



Global Casting Magazine

世界铸造

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SEP 2022 VOLUME 12 NUMBER 3



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迈格码（苏州）软件科技有限公司
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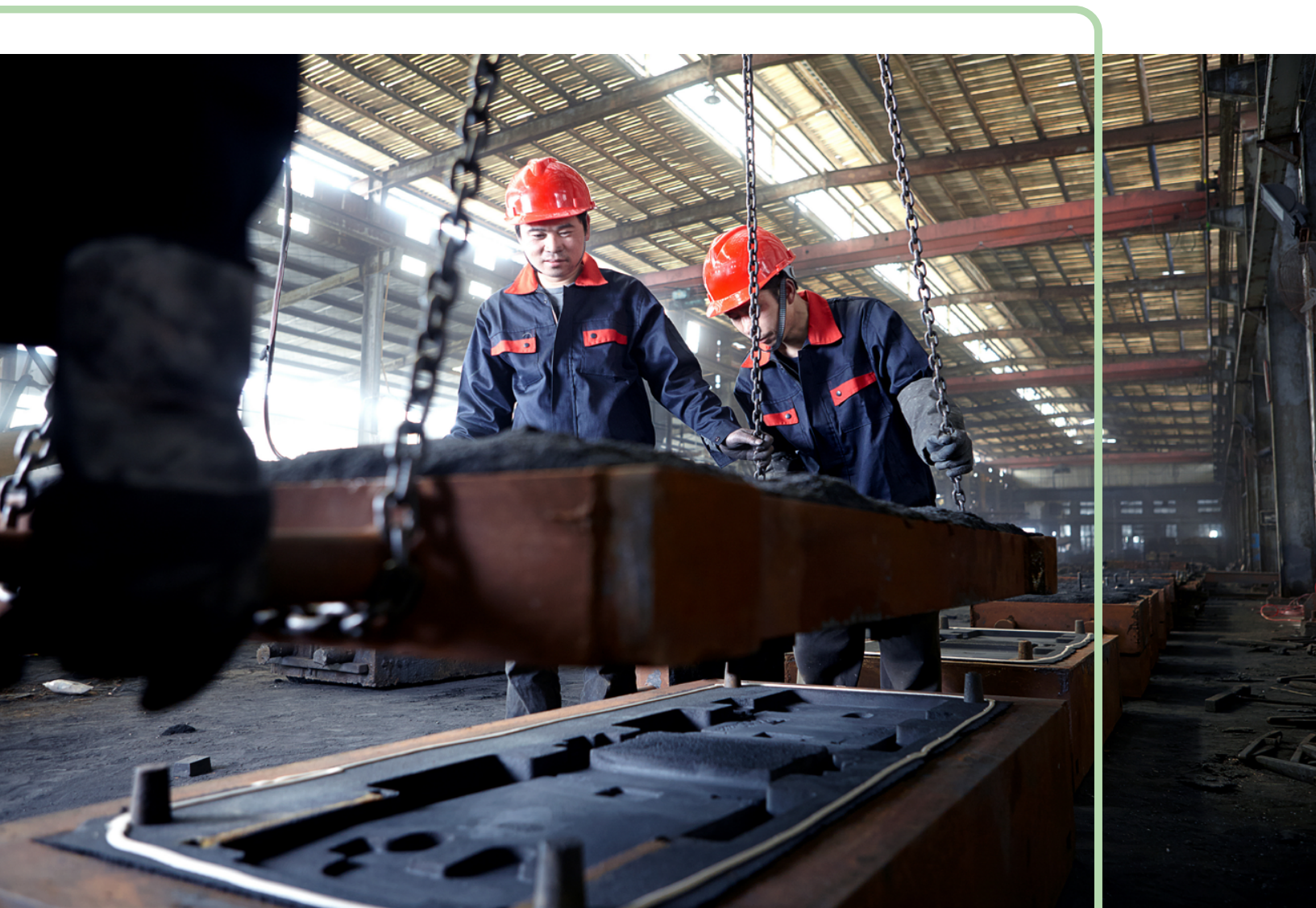
Your partner in process improvement

Building long-lasting partnerships with our customers

Elkem can help you with more than just the right alloy selection throughout your casting process; we work with you on tailored solutions to improve casting quality at the best cost.

Our globally based technical engineers provide on-site assistance and advice as part of our integrated service for our valued customers. This is backed up by our metallographic laboratories providing detailed analysis to scientifically show the value of our projects.

Working together, we can address challenges, improve processes, reduce costs, and remove waste.





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CHINA FOUNDRY ASSOCIATION 中国铸造协会

Publisher/President/ 出品人 / 会长
Libo Zhang/ 张立波

Senior Editor/ 主编
Thomas Gao/ 高巍, gaowei@foundry.com.cn

Quality Supervisor/ 质量总监
Yajuan Yuan/ 袁亚娟, yuanyajuan@foundry.com.cn

Editor & Advertising/ 编辑及广告
Maggie Li/ 李蒙蒙, limengmeng@foundry.com.cn

Sofia Nie/ 聂飞, niefei@foundry.com.cn

Graphic Designer/ 平面设计
Nina Tang/ 唐雅静, tangyajing@foundry.com.cn



张立波
出品人
中国铸造协会

FOUNDRY-PLANET.COM

Publisher/Editor

Thomas Fritsch, tf@foundry-planet.com

Content/Website Management

Maximilian Schrock, ms@foundry-planet.com

Advertising Sales

Oanh Larsen, ons@foundry-planet.com
Matthias Amann, ma@foundry-planet.com

Marketing

Florian Amann, amann@kanat-mediaverlag.de
Andreas Kanat, ak@foundry-planet.com



Thomas Fritsch
Publisher/Editor-in-Chief
Foundry-Planet.com

SUPPORTING ORGANIZATIONS 支持单位



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Industrial Modules: Natural silica sand, Resin coated sand, Foundry solid waste treatment, Artificial spherical sand, 3D printing sand, Foundry sand reclamation, sand reclamation equipments, production lines, Resin coated sand production lines, Foundry sand testing equipments, Technical consultant For foundries

联信球形人造砂产品

是联信铸砂集团与日本山川产业株式会社合资合作，专门生产高端人造球形砂，如熔融陶瓷砂。

Joint venture with Japan Yamakawa Sangyo Co., Ltd, specializing in the production of high-end artificial spherical sand, such as fused ceramic sand.

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- 1、热膨胀系数小，铸件膨胀缺陷倾向小。
- 2、球形度高，流动性好，易于填充，砂芯透气性好。
- 3、表面光滑，砂型/芯强度高。
- 4、组织致密、耐火度高，再生复用性好，性价比高。

1、 Features of low thermal expansion, it can reduce the casting defect resulted from thermal expansion of the casting.

- 2、 Spherical roundness with excellent flow ability for mold filling, the sand core has good air permeability.
- 3、 Smooth & clean surface to boost bonding efficiency, the mold and cores achieve higher strength
- 4、 Dense structured, high refractoriness, good regeneration reusability, and high cost performance.

Application of The fused ceramic sand:

- 1、 Core sand of cold box process for High-valued castings, special structure castings
- 2、 For SLS 3D printing process
- 3、 High grade resin coated sand production
- 4、 Precision casting process
- 5、 Heavy steel casting mold

铸造砂检测设备

联信铸砂集团研发生产专业的铸造砂检测设备，操作简便，检测更为精准！

Lianxin's foundry sand testing equipments featuring Easy operation, Accurate test



型砂抗折强度检测仪
Molding sand flexural strength tester



型砂发气量检测仪
Molding sand gas emission tester



型砂透气性检测仪
Product-Molding sand permeability tester



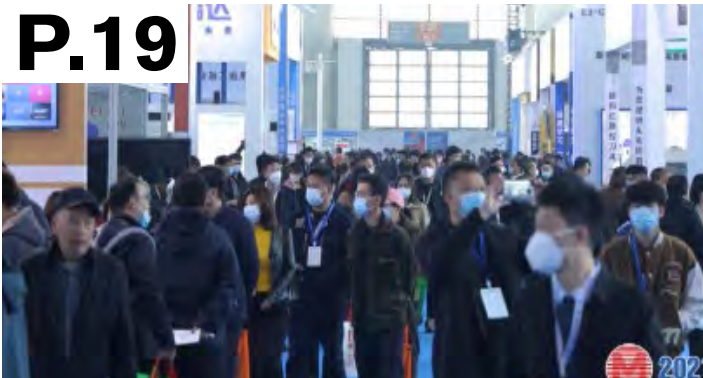
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Metallurgy



Heat Treatment

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Jl. Raya Perjuangan No. 88, Kebon Jeruk
Jakarta - Indonesia 11530

Tel: (62) 21 5366 0804 Fax: (62) 21 5325 890

Email: imt@pelitapromo.com

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MAIN PRODUCTS 主要产品

TYPE
01

用于黑色&有色金属感应电炉的酸性、中性、碱性系列干振料

Acid, neutral and alkaline series dry vibration materials for black-non-ferrous metal induction furnaces

TYPE
02

各种浇包及反射炉等熔炼炉用的浇注料

Castables for smelting furnaces such as various ladle and reverberatory furnaces

TYPE
03

线圈胶泥、炉嘴料、炉领料

Coil cement, furnace nozzle material, furnace collar material

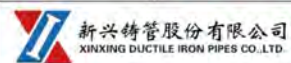
TYPE
04

各种可塑修补料、预制件等.....

All kinds of patching plastic materials, prefabricated parts, etc.

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SOME USERS' COMMENTS ON US 部分合作用户



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Zhongyiming's Intelligent Grinding and Cutting Robots will Show at METAL CHINA

天津中屹铭智能打磨切割机器人即将亮相 中国国际铸造展

In the first half of 2022, Tianjin Zhongyiming Technology Co., Ltd. has taken various measures to expand both domestic and overseas markets. The full series of high stiffness intelligent grinding equipment and cutting robot are highly recognized by customers, and its order book is increasing greatly.

Through its deep application of cutting and grinding machine integrated with finishing and one-step technologies in castings with high viscosity, high heat and high hardness, such as large, medium and small-sized cast iron, cast steel, non-ferrous metals, aluminum and investment casting, Zhongyiming company takes advantage of its high stiffness grinding and special cutting spindles, combined with spatial origin positioning, random spatial positioning, phototypesetting technology, spatial measuring arm, automatic compensation for positioning error, laser, it has solved the difficulty in oversized cylinder block, axle housing, bolster, side frame, which resulting in a comprehensive solution including cutting, grinding, drilling, polishing.

For Zhongyiming, every technical breakthrough is an important milestone and a new starting point for its development. Zhongyiming will bring its latest products to display at METAL CHINA 2022, from September 19-21 in Shanghai. Welcome to visit our booth 3C04. ■

2022年上半年,天津中屹铭科技有限公司多措并举,积极拓展国内及海外市场,国内外客户对中屹铭高刚度全序列智能打磨切割机器人设备的认可度越来越高,订单量大幅增加。

通过对大、中小型铸铁、铸钢、有色金属、铸铝、精密铸造等高粘、高热、高硬度特性铸件切磨一体精修、一序完成技术的成熟应用,中屹铭利用自身在高刚度磨切专用主轴市场的领先优势,结合空间原点定位、随机空间定位、照排技术、空间测量臂、定位误差自动补偿、激光纠错等技术多元化组合解决超大件如超大缸体、桥壳系列、摇枕、侧架等切磨难题,根据多形态分析判研,形成超大铸件切割、打磨、钻孔、抛光等综合性解决方案。

对于中屹铭而言,每一次技术性突破都是铸件打磨切割技术发展的重要里程碑和新的起点。中屹铭将携最新的高刚度打磨设备参加于2022年9月19-21日在上海举办的第二十二届中国国际铸造博览会,欢迎莅临展位参观、洽谈,展位号:3C04。■



Official Launch of FHZL 5th Generation Sand 3D Printer

峰华卓立第五代智能高效 3D 砂型打印机正式发布

Recently, Guangdong Fenghua Zhuoli Technology Co., Ltd(FHZL) announced that the 5th generation sand 3D printer developed independently by the company has been successfully launched. It is a brand new industrial 3D printing machine based on the latest development of the binder jet technology and is designed for the upgrade of digital modern production lines for traditional foundries to lean in Industry 4.0. FHZL 5th Generation sand 3D printer is equipped with compacter structure, superior printing performance and higher automation via adding a remote control system and a monitoring system through mobile phone application and a new communication function with other equipment to support an comprehensive casting production line. It is a consummate solution for high automated continuous production.

Meanwhile, the company has moved to a new plant in Foshan city with an area of over 15000m2 as the new headquarter, aiming to better support the fast growing of sales & manufacturing of FHZL 3D printer and the R&D and application of binder jet 3D printing technology (for sand casting, metal & ceramic etc.). After moving to the new plant, the manufacturing capacity of FHZL 3D printer will be highly enhanced and the mass production of the large-sized printer PCM2500 can be carried out smoothly. The new headquarter of FHZL will serve as a demonstration base for the Guangdong-Hong Kong-Macao Greater Bay Area, to provide professional digital manufacturing solutions, consultant service and technical training for more and more customers.

As the pioneer of sand casting 3D printing technology in China with over twenty years' experience, FHZL has entered the fruitful rapid growing phase so far. The 3D printing machines developed and manufactured on FHZL's own, have been sold to all over the world (Japan, Brazil, India, Russia, Belarus etc.)

FHZL products includes: 1. Full series of sand casting binder jet 3D printer PCM450 to PCM 2500 (total 8 models in different print size); 2. Binder jet metal 3D printer: BJM480; 3. Binder jet ceramic 3D printer. The company will spare no efforts to accelerate the R&D of the state-of-the-art 3D printing technology on sand casting, metal and ceramic to provide supreme service to customers from various industries.

FHZL will take part in the 20th China International Foundry Expo(Metal China), which will be held in

广东峰华卓立科技股份有限公司近日宣布，公司研发成功的第五代砂型打印机正式推出，该设备相较于上一代更加紧凑，更适合产业化布局，砂型打印质量也更好，同时还增加了远程控制系统及手机 APP 监控系统并可实现与其它设备的通讯，是一款面向数字化智能工厂设计的新智能工业级 3D 打印机。

同时，公司总部已搬迁至位于广东佛山南海区的新工业园区，使用面积超过 15000 平方米，为 3DP 打印（砂型、金属、陶瓷等）技术的研发、销售、制造和技术应用提供了更强大的动力。新总部将作为粤港澳大湾区的示范基地，为更多的客户提供数字化制造解决方案、咨询服务和技术培训。

随着峰华卓立佛山新工厂的投产，将极大提升 3D 打印装备的交付能力，并实现 PCM2500 大幅面打印设备的量产，第五代迭代机型融合了连续化生产和远程运维的自动化控制解决方案。

峰华卓立是中国 3D 砂型打印技术的开创者，通过二十余年的发展，公司已进入高速发展期。其自主研发、设计、生产制造的产业化 3D 打印装备已销往全球多个国家和地区（包括欧洲、东南亚、日本、南美洲、北非等）。自 2019 年起，峰华卓立还在四川成都陆续投产一个占地 70 亩的 3DP 砂型打印 + 铸造的产业应用基地和一个占地 10000 平方米的 3D 打印陶瓷 / 金属中试基地。峰华卓立成都基地将侧重于推进 3D 打印应用技术研发和落地，新厂全面达产后年产值将超过 3 亿元，同时第一条自主批量化生产的数字化 3D 打印产线也将于 2022 年底落地成都。

未来，峰华卓立将更加注重研发的持续投入和对全球客户的优质服务，加快在铸造数字化、金属和陶瓷等 3DP 技术的推广和研发，已经推出 PCM300 到 PCM2500 Plus 全系列八个规格的第五代工业级砂型打印机、FH480-M 金属打印机、FH450/800-C 陶瓷打印机等系列产品，峰华卓立将竭诚为各行业客户提供更多的增材制造解决方案。

2022 年 9 月 19-21 日，峰华卓立公司将携最新



National Exhibition and Convention Center (Shanghai) from 19-21 September. Welcome to visit our booth: HALL 3, 3E02-2. Your visit is our honor.

For any inquiry, please call us at +86 75788775583 or write to us 3dp@fhzl3dp.com. ■

3D 打印设备亮相于国家会展中心（上海）举办的第二十二届中国国际铸造博览会、第十六届中国国际压铸工业展览会暨第十六届国际有色及特种铸造展览会，期待您莅临参观洽谈，展位号：3号馆 3E02-2。欢迎有各种产业应用需求以及具有粘结剂、金属、陶瓷、碳纤维、高分子等材料粉末开发能力的企业洽谈合作，联系人：张先生，联系电话：18673163568，Email: zw@fhzl.co。■



LFS will Show at METAL CHINA & DIECASTING CHINA 2022

河北龙凤山铸业将亮相 2022 年铸博会 & 压铸展

Hebei Longfengshan Casting Industry Co., Ltd., founded in 1999 and located in Qinglongshan Industrial Park, Wu'an, Handan, is a "national high-tech enterprise" specializing in the research, development and production of high-end iron-based new materials for casting.

The ultra-high and high purity pig iron for casting of Longfengshan are irreplaceable in the field of high-end equipment manufacturing. The company independently develops and produces high-tech raw materials for casting, with better uniformity, mechanical properties, toughness and fatigue resistance. With high purity, high consistency and high stability, it is widely used in the production of high-end castings and large forging parts for high-speed rails, ships, offshore engineering, aerospace and other industries.

Relying on the established research and development platform of iron-based new materials, the company has deeply developed high-end iron-based new materials such as ultra-high purity iron, iron-based metal powder, high temperature and corrosion-resistant pig iron. It is devoted to building a research and development production base of new materials for high-end equipment manufacturing in China, and is determined to become a leader in the field of global iron-based new materials.

Longfengshan will bring its latest products to the 20th China International Foundry Expo(Metal China 2022), the 16th China International Die Casting Industry Exhibition (Diecasting China 2022) and the 16th International Nonferrous and Special Casting Exhibition, from September 19 to 21, 2022, National Exhibition and Convention Center (Shanghai), booth number is Hall4.1, 4D01. ■

河北龙凤山铸业有限公司始建于 1999 年，位于古都邯郸武安青龙山工业园区，是专业研发生产高端铸造用铁基新材料的“国家高新技术企业”。

龙凤山公司的铸造用超高纯生铁和高纯生铁在高端装备制造领域具备有不可替代性。公司自主研发生产铸造用高新原材料，其均匀性、机械性能、韧性和抗疲劳性等更好，具有高纯净度、高一致性、高稳定性的优异性能，产品广泛应用于核电、军工、高速列车、船舶、海洋工程、航空航天等行业的高端铸件和大型锻件上。

公司凭借业已建立的铁基新材料研发平台，深度开发超高纯铁、铁基金属粉末、耐高温耐腐蚀生铁等高端铁基新材料，打造中国高端装备制造新材料研发生产基地，立志成为全球铁基新材料领域的引领者。

2022 年 9 月 19-21 日，龙凤山公司将携最新产品亮相于国家会展中心（上海）举办的第二届中国国际铸造博览会、第十六届中国国际压铸工业展览会暨第十六届国际有色及特种铸造展览会，期待您莅临参观洽谈，展位号：4.1 号馆 4D01。■



Ka Shui Group Signed a Strategic Cooperation Agreement with DECH Future

嘉瑞集团与德创未来签订战略合作协议

On July 22, Ka Shui Group and DECH Future signed a strategic cooperation agreement, marking the beginning of the in-depth strategic cooperation relation. According to the agreement,

2022 年 7 月 22 日，嘉瑞集团与德创未来双方签订战略合作协议，标志着双方正式开启全面深化战略合作伙伴关系。根据协议内容，双方将在重卡轻量化项目开

both parties will carry out in-depth strategic cooperation in lightweight project development, supporting services, brand promotion and business model exploration.

This collaboration will focus on the lightweight application of magnesium alloy in heavy truck vehicles. Both parties will take advantage of their core strengths with resources complementary to each other, to achieve a win-win situation.

Earlier in 1998, Ka Shui Group began to set foot in the magnesium alloy die casting industry. Since then, the company has continuously improved its strength in the research and development of new magnesium alloy materials, production equipment and process technology, and provided customers with high-quality production solutions. Now, the company has rich experiences in providing services of magnesium alloy parts for new energy vehicles.

Ka Shui Group not only has a R&D team for magnesium alloy lightweight technology, but also has 4000t and 5000t of large-scale die-casting machines to produce giga castings, which can provide magnesium alloy parts for new energy commercial vehicles, helping to realize the sustainable development.

Visit us at METAL CHINA+Diecasting China 2022 from September 19-21, National Exhibition and Convention Center (Shanghai), booth 4A09. ■

发、配套使用、品牌推广以及商业模式探索方面展开深度战略合作。

此次合作将重点围绕镁合金在重卡车辆的轻量化应用，双方将充分利用自身核心优势，实现资源互补，合作共赢。

1998年，嘉瑞集团开始涉足镁合金压铸行业。自此，公司不断在镁合金新材料研发、生产设备及工艺技术等方面提升实力，为客户提供优质的生产解决方案，现已具备为众多知名汽车提供新能源汽车镁合金零部件生产服务的丰富经验。

此外，嘉瑞集团不仅拥有镁合金轻量化研发团队提供技术支持，还配套有4000吨及5000吨大型压铸生产设备生产大型铸件，可为新能源商用车镁合金零部件提供生产支持，助力实现“双碳”目标。

2022年9月19-21日，嘉瑞集团将继续携最新产品参加在国家会展中心（上海）举办的第二十届中国国际铸造博览会、第十六届中国国际压铸工业展览会。展位号：4A09。■

Mingzhi 2000L Core Shooter Ready for Giga Coldbox Core

明志科技成功挑战 2000 升超大型冷芯盒制芯系统

To meet the robust casting production requirements of large domestic marine engines, since June 2021, Mingzhi Technology has focused its research and development efforts, resulting in breakthroughs in over 10 areas of technology. The advances include a high-flow sand shooter, an efficient curing system and core box tooling unit, and most significantly, the design and manufacture of Mingzhi Technology's new giga cold core box core shooting machine. With a sand shooting volume of 2000 liters, along with the supporting systems that include core setting, a coating manipulator and a drying system, the Mingzhi 2000L Core Shooter once again sets a new record among core making equipment.

The Mingzhi Technology family extends its gratitude to all partners and friends in the foundry industry who collaborate in making these new developments in technology possible. We look forward to your visit to our facilities in Tongli Town, Suzhou! In addition, join us at the Mingzhi Technology booth (Hall 3 A02), during the National Exhibition and Convention Center (Shanghai) from September 19 to 21, 2022. ■

为满足国内大型船用发动机的铸件生产要求，自2021年6月起，明志科技历经一年多时间，完成了对于大流量射砂机构、高效固化系统以及芯盒工装等10余项技术的研发攻关，设计并制造完成了一次射砂量达到2000升的超大型冷芯盒射芯机以及相关配套的取芯、涂料机械手及烘干系统，再次突破了制芯装备的上限。

感谢各位铸造同仁对于明志科技的关注，并欢迎您光临苏州同里 - 明志科技，亲临感受！

9月19-21日，我们在国家会展中心（上海）的明志科技展台（3号馆3A02）期待您的光临！■

Bright Solutions for Your Future

更好的方案 更好的铸造

Loramendi is a world-class reference company in providing comprehensive solutions for core manufacturing processes (blow molding or additive manufacturing) and vertical molding of foundry companies. It is a machinery manufacturing company with three different business units: core manufacturing, vertical molding and services (refitting or refitting machines that are already in operation. It also provides auxiliary services and equipment spare parts). In the past there were only 3 business: Coremaking, Moulding & Service... Now we are proud to include the latest : ICP 3D Printing (Industrialization of Core Printing). Our experience in sand core manufacturing, processing and technology has put us on the path of digitalization, interconnection and environmental protection solutions.

The business focus of Aurrenak is to design and manufacture molds for the cast iron and cast aluminum industries. The main products are: gray iron casting: pattern board, box, assembly fixture; High pressure die castings: molds, trimming molds; Aluminum low pressure die castings: mold, core box; Aluminum gravity die casting: mold, core box, die casting machine.

Loramendi & Aurrenak merged into a group company in 2005, and has been committed to the Chinese market for a long time. The predecessor of the company has been a global leader in the foundry industry since its establishment 50 years ago. Loramendi & aurrenak is a globally recognized industry benchmark, providing solutions in green technology fields such as electrification (motor) and inorganic processes and e-vmm (electric vertical molding machine).

Loramendi & Aurrenak continues to consolidate its business in Europe, Asia and the Americas, and its customers represent the world's leading manufacturers in the automotive industry. We have been working closely with Chinese customers and providing the most intelligent and complete solutions in the foundry industry. Our technical knowledge and extensive casting solution portfolio always meet the requirements of end users. We focus on customers and establish long-term cooperative relations with customers and suppliers is the key to our work. Our efforts have made positive contributions to the technical development of customers in the foundry industry. At the same time, we provide excellent after-sales service throughout the service



Loramendi 在为铸造公司的核心制造工艺（吹塑或添加制造）和垂直成型提供全面解决方案方面是一家世界领先水平的公司。它是一家机械制造公司，有三个不同的业务部门：核心制造、垂直成型和服务，包括改装或改装已在运行的机器，提供辅助服务和设备备件等。过去我们只有三种业务：制芯、成型和服务，现在，我们很自豪地加入了最新的 ICP 3D 打印业务（核心打印的工业化）。我们在砂芯制造、加工和工艺方面的经验使我们走上了数字化、互联和环保解决方案的道路。

Aurrenak 的业务重点是铸铁和铸铝行业设计和制造模具。主要产品有：灰铁铸造：模具、芯盒、装配夹具；高压压铸件：模具、修边模具；铝制低压压铸件：模具、芯盒；铝重力压铸：模具、芯盒、压铸机。

Loramendi & Aurrenak 于 2005 年合并为集团公司，长期以来致力于深耕中国市场，公司前身成立 50 年来一直是铸造行业的全球领导者。Loramendi & Aurrenak 是全球公认的行业标杆企业，在电气化（电机）以及无机工艺和 E-VMM（电动垂直成型机）等绿色技术领域提供解决方案。

Loramendi & Aurrenak 不断巩固在欧洲、亚洲和美洲的业务，其客户代表了汽车行业的世界领先制造商水平。

life of our products to achieve the best performance.

Our experience in core making, tooling and processes has put us on a path towards digitalization, interconnection, and environmentally friendly solutions. Loramendi & Aurrenak are globally recognised benchmarks, providing solutions in areas like electrification (electric motor) as well as green technologies such as inorganic processes and E-VMM (Electric Vertical Moulding Machines).

Customer focus and developing long-term partnership relationships with our customers and suppliers are key, actively contributing to the technological development of our customers within the foundry sector.

In addition, we provide an excellent after-sales service throughout the entire service life of our installations in order to achieve maximum performance.

Welcome to visit Loramendi & Aurrenak at the 20th China International Foundry Expo(Metal China), from 19-21 September, National Exhibition and Convention Center (Shanghai). Booth: Hall 3, 3B01-2. ■

一直与中国的客户密切合作，并提供铸造行业最智能、最完整的解决方案。我们的技术知识和广泛的铸造解决方案组合始终适应最终用户的要求。我们以客户为中心，与客户和供应商建立长期合作关系是我们工作的核心，我们的努力对铸造行业客户的技术发展做出了积极贡献。同时，我们在产品的整个使用周期提供卓越的售后服务，以实现最佳性能。

2022年9月19-21日，Loramendi & Aurrenak 将携最新产品和设备亮相于国家会展中心（上海）举办的第二十二届中国国际铸造博览会、第十六届中国国际压铸工业展览会暨第十六届国际有色及特种铸造展览会，期待您莅临参观洽谈。展位号：3号馆 3B01-2) ■

Millison's 8800T Super Large Structural Vehicle Body Parts Goes into Mass Production

美利信科技 8800T 超大型车身结构件成功量产

On June 29, 2022, the ceremony and technical seminar on "Millison's 8800T Super Large Structural Vehicle Body Parts Going into Mass Production" was held in Chongqing. Millison is a well-known die-casting enterprise, a standing board member of China Foundry Association (CFA), and a rotating chairman of the Diecasting Branch.

The first integrated die-casting structural parts for lower vehicle body has went through trial production in Millison's Chongqing factory and has been delivered to customers after successful mass production. The products meet all requirements of the customer, and the technology and quality control all reach to a high level.

Mr. ZHANG Libo, President of CFA, and Mr. GAO Wei, Executive Vice President of CFA, were invited to attend the ceremony. Mr. Zhang said, as the pioneer of China's top 50 die casting enterprises and one of the top 100 foundry comprehensive enterprises, and a company in the list of "champion demonstration enterprises in one single manufacturing sector", Millison has deepened its cooperation with a number of world-renowned automobile and communication industry enterprises, high-end equipment enterprises, the national magnesium alloy material

2022年6月29日，中国铸造协会常务理事单位、中国铸造协会压铸分会轮值理事长单位、知名压铸企业——重庆美利信科技股份有限公司“8800T 超大型车身结构件量产仪式暨技术交流会”隆重举行。

美利信科技首个一体化压铸下车身结构件在重庆工厂试制成功，并实现批量交付客户，产品各项性能指标均满足客户要求，工艺技术和品质管控处于行业领先地位。

中国机械工业联合会副会长、中国铸造协会会长张立波，中国铸造协会专务高巍应邀出席仪式。张立波会长在致辞中指出：作为中国压铸50强和铸造综合百强排头兵、“国家制造业单项冠军示范企业”，美利信科技与多家世界知名汽车企业、通信企业，与高端装备企业、与重庆大学国家镁合金材料工程技术中心等深化合作，共同致力于中国压铸未来的探索与实践，为中国铝合金铸造领域做出了重要贡献。

“今天的量产仪式，不仅标志着美利信的技术生产能力

center of Chongqing University. They have jointly committed to the exploration and practice of the future of die casting, and have made important contributions to China's aluminum alloy casting industry.

The President of Millison company, YU Yajun said: "The ceremony not only marks that the technology and production capacity of Millison has reached to a new level, but also lays a new foundation for the exploration and practice of die-casting technology in the field of automotive lightweight. We will follow the national strategy, and continue to promote the development of intelligent manufacturing, automotive and die-casting industry in the future."

Visit us at METAL CHINA+Diecasting China 2022 from September 19-21, National Exhibition and Convention Center (Shanghai), booth 4A02. ■

迈上了新台阶，更为压铸工艺在汽车轻量化领域的探索与实践奠定了新基础。我们将以此为新起点，围绕国家战略，共同推动中国智能制造、汽车工业、压铸产业的兴旺发展，走向世界！”美利信科技总裁余亚军表示。

2022年9月19-21日，美利信科技将继续携带最新产品参加在国家会展中心（上海）举办的第二十届中国国际铸造博览会、第十六届中国国际压铸工业展览会、第十六届国际有色及特种铸造展览会。展位号：4A02。■

Asian Foundry Association Working Meeting Held Online 亚洲铸造业联合会工作会议线上召开

On June 8, 2022, the first working meeting of Asia Foundry Association in 2022 was held online. Indonesian Foundry Industries Association, China Foundry Association (CFA), Federation of Malaysian Foundry & Engineering Industries Association, Hong Kong Foundry Association, The Institute of Indian Foundrymen, Japan Foundry Society, Korea Foundry Society, Mongolian Metallurgical Association, Pakistan Foundry Association, Taiwan Casting Industry Association, Thai Foundry Association, Vietnam Foundry Metallurgy Science Technology Association, All the presidium units participated in the meeting.

Chairman of China Academy of Machinery Science & Technology Group Co., Ltd., Mr. Wang Decheng, director Ms. Li Xiaodong, director Ms. Zhang Xiaolu, chairman of AFA, vice president of China Machinery Industry Federation,



2022年6月8日，2022年亚洲铸造业联合会第一次工作会议在线上召开。中国铸造协会、印度铸造业者协会、印度尼西亚铸造业协会、马来西亚机器厂商总会、香港铸造业总会、日本铸造协会、韩国铸造协会、蒙古冶金协会、台湾铸造品工业同业公会以及巴基斯坦、泰国、越南铸造协会等联合会主席团单位悉数参会；中

国机械科学研究总院集团有限公司董事长王德成、部长黎晓东、主管张晓璐，亚洲铸造业联合会当值主席、中国机械工业联合会副会长、中国铸造协会会长张立波，亚洲铸造业联合会执行委员、中国铸造协会执行副会长范琦，亚洲铸造业联合会秘书长、中国铸造协会专务高巍，中国铸

President of CFA Mr. Zhang Libo, Executive Member of AFA and Executive Vice President of CFA Ms. Fan Qi, Secretary General of AFA and Executive Vice President of CFA Mr. Gao Wei, Assistant Secretary General of CFA Ms. Chen Xing, Director Mr. Zhao Gang attended the meeting; The executive member of the AFA, vice president of Jinan SQ Group Co., Ltd. Mr. Zhu Jianxun, attended the meeting; CFA Thailand Office and Taigang Company General Manager Mr. Ding Qingling attended the meeting. The meeting was presided over by Gao Wei.

According to the latest world casting production statistics, in 2020, the total global casting output is 105.5 million tons, and the casting output in Asia is 72 million tons, accounting for about 72% of the total global output. It can be said that Asian foundry has a decisive influence on the global foundry industry. It is the mission of AFA to jointly discuss and plan the development of the Asian foundry industry and organize practical cooperation. Since its establishment on September 18, 2019, AFA has been serving the development of Asia foundry industry in all fields, promoting exchanges and cooperation among members, strengthening education and training, improving the level of environmental protection, promoting sustainable development of Asia and even the global foundry industry. Despite many difficulties, such as the impact of COVID-19, the exchanges and cooperation among the members continued, and the cohesion gradually increased.

Zhang Libo said in his speech that the Asian Foundry Federation adheres to the core concept of "communication, cooperation, development, and win-win", based in Asia and facing the world, while consolidating the consensus of the Asian foundry industry and enhancing the exchanges and friendship between Chinese and foreign foundry organizations. , and continuously deepen the international cooperation in the foundry industry. At present, there is still a certain gap in the development level and scale of the foundry industry among Asian countries and regions. It is imperative to strengthen regional cooperation and promote the overall improvement of the Asian foundry industry to develop towards a green, intelligent and high-quality development. "Resource sharing and common development" is our eternal theme. We hope that all member units will make good use of the platform of the Asian Foundry Federation to explore new models, connect new supply and demand, unblock new chains, and strengthen

造协会秘书长助理陈星、国际交流与展览部赵刚等领导于北京主会场出席会议；作为联合会执行委员，济南圣泉集团股份有限公司副总裁祝建勋与会；中国铸造协会泰国办事处、泰钢公司总经理丁庆玲参加会议。会议由中国铸造协会专务高巍主持。

2020年，全球铸件总产量为10,550万吨，其中亚洲铸件产量达7,200万吨，约占全球铸件总产量的72%。毋庸置疑，亚洲铸造业对全球铸造业的影响举足轻重，共同探讨和谋划亚洲铸造业的发展，组织起务实的合作，是亚洲铸造业联合会的责任与使命。自2019年9月18日成立以来，亚洲铸造业联合会以服务亚洲铸造行业各领域发展、

促进成员单位间交流与合作、加强铸造行业人才教育和培训、提高铸造业环保水平、推动亚洲铸造业乃至全球铸造业的可持续发展为宗旨，虽然面对新冠疫情影响等诸多困难，但各成员间的交流与合作持续不断，凝聚力不断上升。



张立波在致辞中表示，亚洲铸造业联合会秉承着“交流、合作、发展、共赢”的核心理念，立足亚洲、面向世界，在凝聚亚洲铸造行业共识、增进中外铸造组织间交流与友谊的同时，不断深化着铸造业界的国际合作。目前，亚洲各国家和地区间铸造业的发展水平和规模仍存有一定差距，加强区域合作、推动亚洲铸造业的整体提升并向绿色、智能、高质量发展势在必行，“资源共享、共谋发展”是我们永恒的主题，希望各成员单位利用好亚洲铸造业联合会的平台，探索新模式、对接新供需、畅通新链条，加强各国家和地区间的交流与合作，共同促进铸造业的发展。

会议上，经联合会主席团成员一致表决，中国机械科学研究总院集团有限公司董事长王德成任亚洲铸造业联合会执行委员。作为现任中国央企的掌门人，王德成自1985年起就开始从事标准化工作，2015年起担任ISO/TC 10/SC 6主席，并参与了多项IEC国际标准制定，制

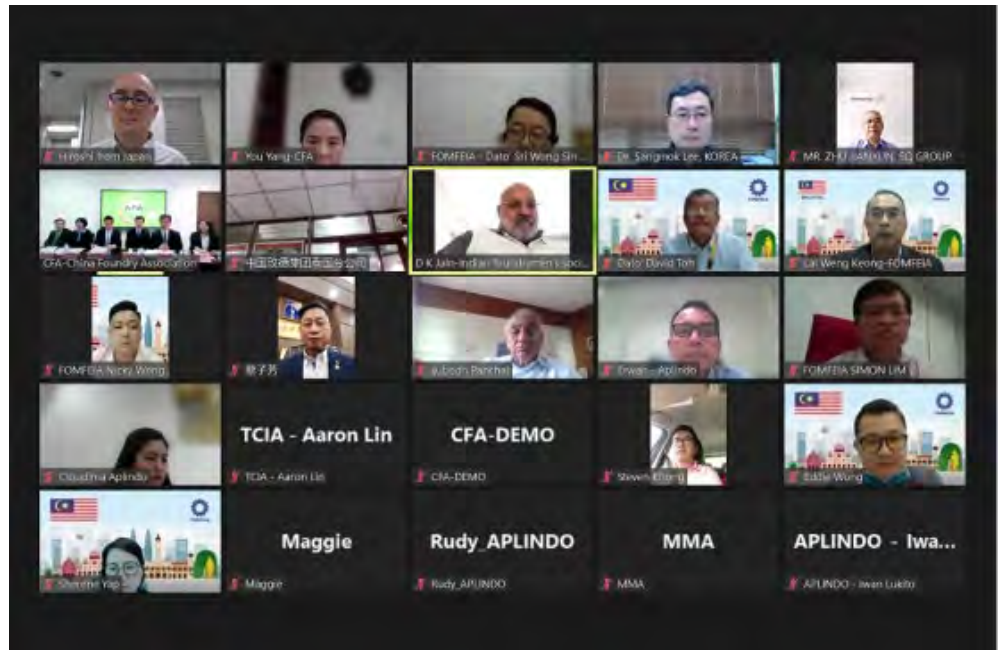
exchanges and cooperation between countries and regions, and jointly promote the development of the foundry industry.

At the meeting, after the unanimous vote of the members of the presidium, Wang Decheng was appointed as the executive member of Asian Foundry Association. As the current head of a state-owned enterprise in China, Wang Decheng has been engaged in standardization work since 1985. Since 2015, he has served as the chairman of ISO/TC 10/SC 6, and has participated in the formulation of a number of IEC international standards. The developed technical product documentation standards provide a guarantee for the transition of product design and manufacturing from 2-dimensional to 3-dimensional. The inauguration of committee member Wang Decheng will definitely help the members of the association in multi-dimensional work such as standard exchange, technology integration, and market expansion, and contribute strength and wisdom to further promote the high-quality development of the regional foundry industry.

The members of the presidium reported on the main work progress in the first half of 2022 and the development of the foundry industry in the region. In the exchange and discussion session, the representatives also introduced the challenges faced by the foundry industry in the region and foreign trade policies under the new situation. A high degree of consensus was reached on Chairman Zhang Libo's proposal to "strengthen the normalization of the federation, and promote cooperation in education and training, vocational skills competitions, technical exchanges and restoration of the foundry industry chain", and expressed that they will continue to deepen exchanges and cooperation with this support, and jointly promote the improvement of the overall strength of the Asian foundry industry.

At last, the representative of the Korea Foundry Society made a special presentation on the 74th World Foundry Conference (Asia Foundry Report) to be held at the BEXCO Convention and Exhibition Center in Busan, from October 16 to 20. Mr. Gao Wei also shared and recommended the content of the international bilingual journal - "Global Casting Magazine" to the delegates.

Under the favorable premise that the global pandemic situation is slowing down at this stage, more countries and regions have gradually resumed offline activities. The time for offline exchanges is just around the corner, and the members will continue to work through normalization, close communication and in-depth cooperation, create a new pattern of coordinated development, and create a better future for the high-quality development of the Asian foundry industry. ■



定的技术产品文件标准为产品设计制造从2维向3维过度提供了保障。王德成委员的就职，必将在联合会成员单位间在标准互通、技术融合、市场拓展等多维度工作中对接助力，为进一步推动区域铸造业的高质量发展贡献力量与智慧。

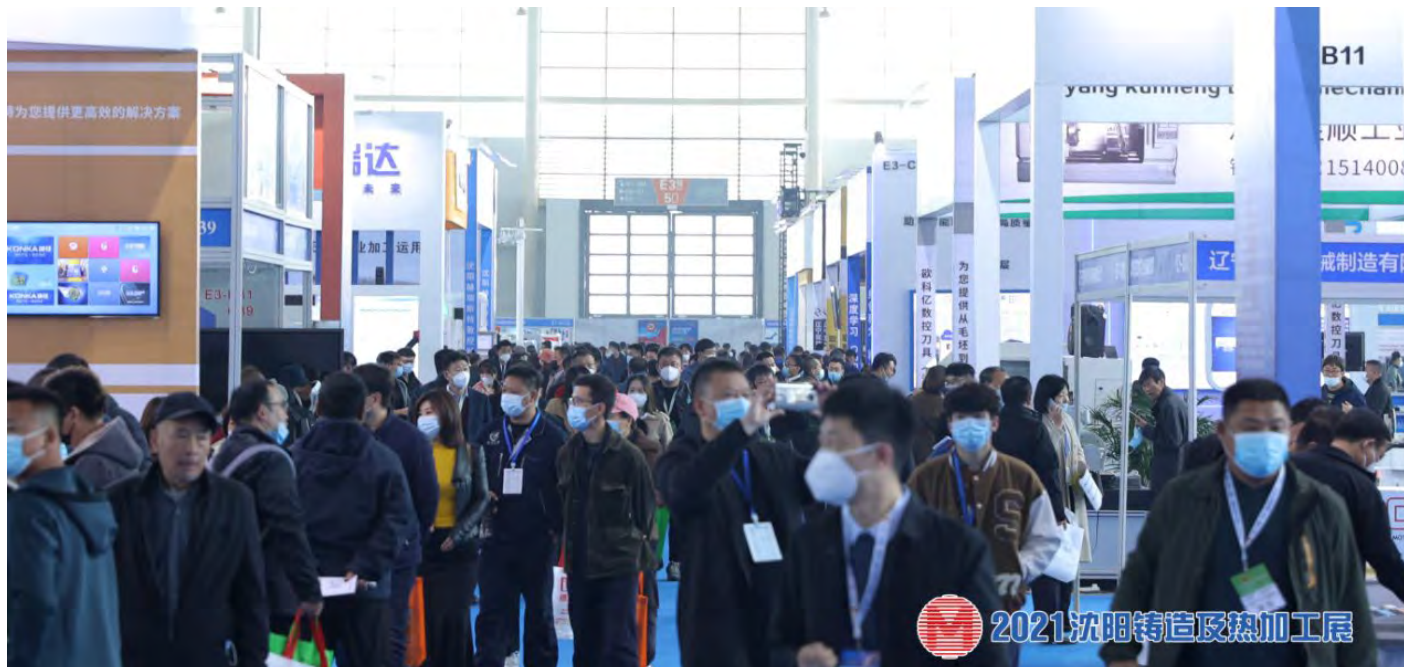
会议听取了各主席团成员单位2022上半年度主要工作进展和本地区铸造行业发展情况汇报。在交流讨论环节中，各成员代表还就新形势下本地区铸造行业所面临的挑战以及外贸政策等进行了介绍，同时，着重就铸造上下游产业供应链现状以及所期望的多方合作发表了意见。对张立波主席提出的“加强联合会常态化工作，促进教育培训、职业技能大赛、技术交流与铸造产业链修复等方面的合作”达成了高度共识，并表示将以此作为支撑不断深入交流与合作，共促亚洲铸造业整体实力的提升。

随后，韩国铸造协会代表还对将于10月16-20日在韩国釜山BEXCO会展中心举办的第74届世界铸造会技术论坛（亚洲铸造报告）进行了特别推介。会议上，高巍还就国际双语期刊——《世界铸造》向与会代表进行了内容分享与推荐。

在现阶段全球疫情趋缓的利好前提下，越来越多的国家和地区逐步恢复了线下活动，亚洲铸造业界同仁线下交流的时间也指日可待，联合会各成员单位也将通过联合会工作的常态化，密切互通、深入合作，再造协同发展新格局，为亚洲铸造业的高质量发展创造更加美好的未来。■

The 2nd Edition of METAL SHENYANG to Launch in Golden October

第二届沈阳铸造展将于金秋 10 月隆重举办



In order to accelerate the reconstruction of the supply and industrial chain of the foundry industry, and promote its upgrading, China Foundry Association will integrate the upstream and downstream resources to launch the 2022 China (Shenyang) International Foundry and Heat-processing Exhibition(METAL SHENYANG), which is the 2nd edition from October 21-25, 2022 in Shenyang.

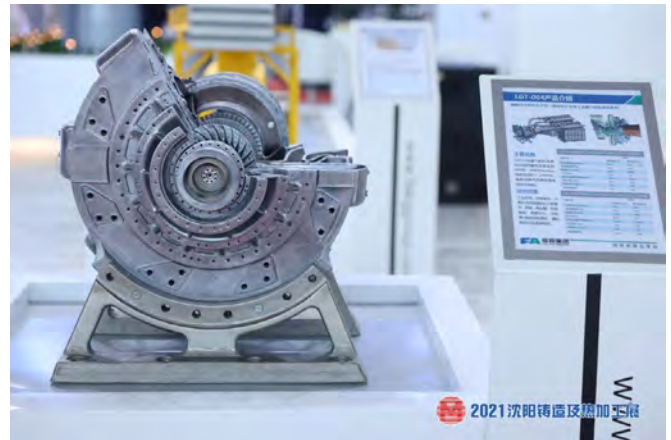
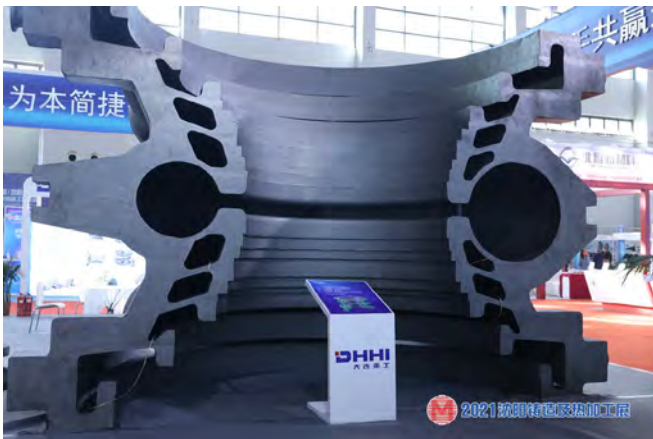
As a regional exhibition hosted by China Foundry Association, the first session was successfully held from October 22 to 25, 2021. During the four-day exhibition period, a total of 139 exhibitors and 15693 professional visitors participated in the exhibition. The first METAL SHENYANG exhibition was a complete success and highly recognized by the industry.

METAL SHENYANG exhibition continues to receive strong support from the local foundry industry associations in Northeast China and attract the great interests of many well-known enterprises. Among them, many well-known equipment, materials and casting enterprises in Northeast China and other provinces will take part in the exhibition, including Dalian Huarui, Lianxin Foundry Silica Sand, Yinfeng Foundry, Shennai Electric Furnace, Juntong Tech, Henglilai, Institute of Metal Research, SQKLY New Materials, Dalian Yuyang, Shenyang

为加速重构疫情后铸造行业供应链、产业链，推动行业转型升级，中国铸造协会整合上下游资源，将于 2022 年 10 月 21-25 日在沈阳举办“2022 中国（沈阳）国际铸造及热加工展览会”。

作为中国铸造协会主办的区域性展会，首届沈阳铸造展于 2021 年 10 月 22-25 日成功举办。4 天的展期中，共有 139 家展商及 15693 名专业观众莅临展会。首届沈阳展取得圆满成功，获得行业高度认可。

本届沈阳铸造展继续获得东北地区各省市铸造行业协会的大力支持，得到了众多行业知名企业的青睐，其中包括大连华锐重工、联信铸砂、沈阳机床银丰铸造、申耐电气、唐山君通科技、禹州恒利来、中国科学院金属研究所、圣泉科利源、大连誉洋、沈阳永达、阜新力达、辽宁普雷特、春潮汽车零部件、丹龙奥龙、建元膨润土、沈阳金安、重庆长江造型材料、承德北雁、洛阳凯林、普友机械、齐齐哈尔重型铸造、北京隆源、淄博大亚、内蒙华腾环保材料、钢研纳克、无锡创想等东北地区及其他省市的知名设备、材



Yongda Casting, Fuxin Wanda, PRETE, CHUNCHAO Group, Dandong Aolong, Jianyuan Bentonite, Jin'an Foundry Materials, Changjiang River Moulding Material, Chengde Beiyan, Luoyang Kailin, Puyou Machinery, Qiqihar Heavy CNC Equipment, Longyuan AFS, Zibo Taa, Huateng Environmental Materials, NCS, Wuxi Create Analytical, etc..

The exhibition will focus on high-quality castings, foundry equipment, environmental protection, 3D printing, intelligent solutions, molds, raw and auxiliary materials, etc. There are many specialized exhibition areas, such as high-end castings exhibition pavillion, raw and auxiliary materials pavillion, equipment area, intelligent manufacturing pavillion, 3D printing area, safety and environmental protection show area.

The exhibition will be dedicated to building a new platform for the development of the foundry industry in Northeast China. Dozens of concurrent activities will be held, such as various forums, matchmaking conference, technology seminars, including the automobile lightweight casting technology seminar, Foundry Summit in the Northeast China industrial base, Machine tool casting technology conference, the release of the casting enterprise directory in Northeast China, as well as the gold award for casting, foundry material and equipment innovation, etc. ■

料及铸件企业参展。

展会将集中展示优质铸件、铸造设备、环保设备、质量检测设备、3D 打印设备、铸造智能化及解决方案、模具、原辅材料等。设有高端铸件及零部件展区、铸造原辅材料展区、铸造装备、模具、智能制造、3D 打印展区、安全与环保展区等多个特色展区。

展会将致力于搭建东北铸造业发展新平台，届时，将举办数十场高峰论坛、供需对接、研讨交流活动，包括汽车轻量化铸造技术交流会、东北三省一区老工业基地铸造行业高峰论坛、中国机床铸件技术交流会、《东北三省一区铸造企业名录》发布，以及铸件金奖、材料金鼎奖、装备创新奖颁奖仪式等丰富多彩的配套活动。■



Elkem Acquires Keyvest to Grow Specialty Business in Refractories

埃肯集团并购 Keyvest 公司，进军耐火材料领域

Elkem ASA has entered into an agreement to acquire KeyVest Belgium S.A, a specialist company in the sourcing of materials and production of metal powders to the refractory industry and other segments including advanced ceramics. This will expand Elkem's product portfolio and create a platform for further growth.

KeyVest was established in 2007 as an independent processing and milling company of silicon carbide and silicon metal powders. The company is also a distributor of related products such as ferrosilicon nitride, fused silica, boron carbide, and aluminium powder. KeyVest focuses on building long-term relationships with its customers and produces around 140 tailor-made products as per customer requirements, with annual revenues around NOK 100 million.

"The acquisition of KeyVest fits well into Elkem's offerings to the refractory market, enabling us to further grow by providing additional specialised products to our current customers, improve our service level and processing capabilities and grow in adjacent segments. Through this agreement, we also secure opportunities for production optimisation. This is in line with Elkem's strategy of growth through increased specialisation," says Elkem's senior vice president for Silicon Products, Inge A. Grubben-Strømnes.

Refractories are materials designed to withstand very high temperatures and are therefore used in furnace linings for instance in the steel, cement and aluminium industries. Elkem offers a wide portfolio of high-quality products for the production of advanced refractory and ceramic products globally, backed by a highly competent staff for customer service, technical assistance and product development. The KeyVest acquisition will further support and expand this offering.

Elkem is acquiring KeyVest from a subsidiary of Holta Invest AS, a privately held investment company headquartered in Oslo, Norway. The transaction was closed 20 June 2022 and the new name of the entity will be Elkem Processing Services Belgium. ■

埃肯集团已与比利时 KeyVest 公司达成收购协议，KeyVest 公司是一家专门为耐火材料行业和包括先进陶瓷在内等其他行业供应材料和金属粉末的企业。这一收购计划将扩大埃肯的产品范围，并为埃肯的进一步发展壮大创造新平台。

KeyVest 公司成立于 2007 年，是一家加工和研磨碳化硅和金属硅粉末的公司。公司也是氮化硅铁、熔融石英、碳化硼、铝粉等相关产品的经销商。KeyVest 公司致力于与客户建立长期的合作关系，可以根据客户需求安排生产。目前可以生产约 140 种定制产品，年收入约 1 亿挪威克朗。

收购 KeyVest 公司可以为埃肯向耐火材料市场进军提供很大帮助，使我们能够通过向现有客户提供更多的专业产品，来取得更多发展，同时可以提高我们的服务水平和加工能力，并在相关领域实现相应增长。通过这项收购协议，我们还可以确保能获得生产优化的机会。这一决定符合埃肯集团通过加强专业化实现增长的战略方针。”埃肯硅类产品高级副总裁 Inge A. Grubben-Strømnes 这样说。

耐火材料是设计用于承受极高温度的材料，因此用于炉衬使用，应用于钢铁、水泥和铝工业。埃肯为全球先进耐火材料和陶瓷产品的生产，提供一系列高品质的产品组合，并同时提供极富竞争力的客户服务、技术援助和产品开发人员等后续支持服务。对 KeyVest 的收购将进一步支持和扩展这一产品和服务。

埃肯正在以总部位于挪威奥斯陆的私营投资公司 Holta 子公司的名义，进行收购 KeyVest 公司的交易。该笔交易于 2022 年 6 月 20 日结束，新实体公司的名字将显示为 Elkem Processing Services Belgium. ■



Everything is Possible-Costamp Giga Tools

Thomas Fritsch, Chief Editor

万事皆有可能 - Costamp 提供大型压铸模具

主编 Thomas Fritsch

During our on-site visit to COSTAMP in Italy, we were able to see for ourselves the wealth of ideas and innovative strength with which the company is equipped. As a company listed on the Milan Stock Exchange AIM, the COSTAMP Group, founded in 1968, is primarily engaged in mold making tools for the die-casting industry and low-pressure die-casting as well as low-pressure forging.

COSTAMP employs almost 300 people across the group and handles several hundred projects a year for its clients. The machine capacity is considerable and includes the latest technology in all areas.

The modern COSTAMP Group also includes various business units that are closely related to casting.

The ALUNEXT business unit operates a small foundry on its premises for the trial series production of HPDC, LPDC and LPF. Here there are die casting cells and a brand-new machine for low-pressure forging in use in the actual foundry. Three HPDC machines from 1900t to 3000t, one LPDC machine and two LPF machines.

As a mold maker, COSTAMP is always at the forefront, together with its customers, when it comes to the possibilities and implementation of projects for light metals in HPDC or LPDC. Customer orientation and thus process technology and economic efficiency therefore have top priority.

Based on long experience and cooperation, technologies have also been developed that give the company a certain unique position. One example is the PiQ² simulation software, which was used to develop a proprietary filling simulation for HPDC, which has met with great interest in the market. Castle, the software application by PiQ² is developed especially for HPCD in aluminum, magnesium and zinc. We will be happy to present PiQ² and the Castle software in a separate article at another time.

Another example is the "Puzzle die" project, which leads to an increase in the economic efficiency and service life of dies that deserves the highest attention.

It is not entirely coincidental that the COSTAMP Group also plays a leading role in the field of giga tools.

As company boss Marco Corti, together with Alberto

在意大利实地考察 COSTAMP 工厂期间，我们亲眼所见感受到了 COSTAMP 公司具有的缤纷创意和创新实力。作为一家在米兰证券交易所 AIM 挂牌上市的公司，COSTAMP 集团成立于 1968 年，主要从事压铸行业的模具制造、也包含低压压铸和低压锻造。

COSTAMP 集团目前有近 300 名员工，每年为其客户服务数百个项目。可用于生产的机器数量相当可观，涵盖了几乎所有领域的最新技术。

目前 COSTAMP 集团的很多业务部门，都与铸造行业密切相关。

业务部门 ALUNEXT 在集团内部有一个小型铸造车间，用于试制压铸、低压铸造和低压泡沫铸造产品。这个车间里有压铸单元和一台可以实际用于生产的全新低压锻造机，以及 3 台 1900t 至 3000t 的压铸机，1 台低压铸造设备和两台低压泡沫铸造设备。

作为一家模具生产企业，在使用压铸和低压铸造生产技术，对轻金属项目的可能性和实施方面，COSTAMP 始终与客户一起走在技术前沿，坚持以客户为导向，同时追求先进的工艺和技术，并将经济效率放在首位。

有丰富的经验和合作的基础，公司一直在持续进行技术开发，这使得公司产品具有独特的一席之地。一个实例是 PiQ² 模拟软件，该软件被用于为压铸开发专用的填充模拟，在市场上引起了广泛关注。Castle 是 PiQ² 的软件应用程序的名字，是专为铝、镁和锌原料的高压铸造而开发的。我们将会发布一篇单独的新文章，来介绍 PiQ² 和 Castle 软件。

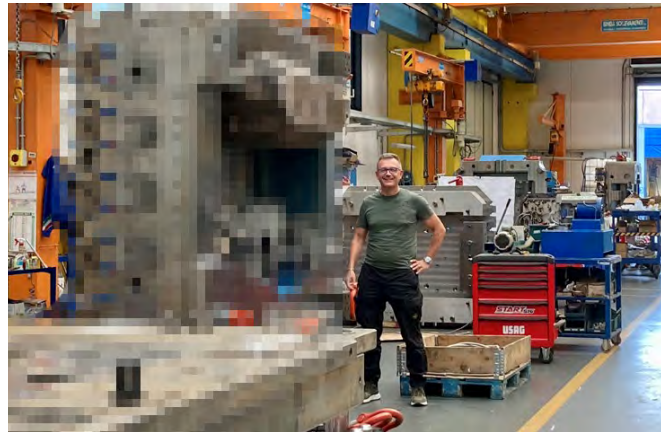
另一个实例是“拼接模具”项目，它提高了模具的经济效益，延长了产品使用寿命，值得高度关注。

COSTAMP 集团在大型模具领域，同样处于领先地位，这并非巧合。

正如公司负责人 Marco Corti 以及 Alberto Ratti 和 Andreas Kant 自豪地告诉我们的那样，



COSTAMP GIGA TOOLS



COSTAMP CEO Marco Corti

Ratti and Andreas Kant, proudly informs us, COSTAMP is one of the few suppliers of giga tools for the 6000 - 9000 ton die casting cells.

Of course, this requires the necessary space and COSTAMP will invest heavily in this area.

In combination with the strong technological basis, a highly motivated team and the most modern equipment, economic solutions are to be achieved with the greatest proximity to the customer, which meet the great challenges of the time. COSTAMP seems to be well equipped and that is why the management is relaxed and optimistic about the future. ■

COSTAMP 是为数不多的、可以为 6000-9000t 压铸单元提供大型模具的供应商之一。

当然，这需要必要生产车间，COSTAMP 将在这方面投入巨资。

COSTAMP 将这些要素整合起来——强大的技术基础、积极进取的团队和最现代化的设备，将在最贴近客户需求的情况下实现最为经济的解决方案，从而应对时代变革带来的巨大挑战。COSTAM 集团目前看上去已经完全准备好了，这大概就是管理层认为公司可以轻松应对并对未来持乐观态度的原因吧。■

Handtmann Invests in Megacasting

汉特曼大力投入一体化大型压铸

Handtmann, the largest family-run light metal foundry in Europe, is the first Tier 1 to invest a mid-double-digit million amount in megacasting. The investment includes both an optimized infrastructure and the purchase of a Bühler Carat 610 extended at the technology site in Biberach.

Die casting has developed rapidly in recent years. The so-called megacasting, which is the joining of several components to form one die casting part, has the potential to revolutionize the car manufacturing process. That is why Handtmann was the first Tier 1 in Europe to decide to offer this solution for structural and body parts.

This is made possible by a close partnership with the Bühler AG. The cooperation forms the optimal symbiosis of the machine manufacturer's know-how combined with Handtmann's innovative manufacturing processes. The

汉特曼是欧洲最大的轻金属铸造家族企业，是第一家在大型压铸领域进行了数百万投资的企业。其投入包括对基础设施进行优化，以及购买布勒 Carat 610 压铸单元，扩展在比伯拉赫的技术中心。

近几年来，压铸发展十分迅速。这里所说的大型压铸，指的是将几个部件连接在一起形成一个压铸件，具有革命性改变汽车制造工艺流程的潜力。这就是为什么汉特曼公司决定要做欧洲第一家为结构和车身部件提供这种解决方案的一级供应商。

这一变化得益于与布勒股份公司的密切合作。这种合作融合了机器制造商的专利技术与汉特曼公司创新的



acquisition of a Carat 610 extended with 61,000 kN clamping force and a shot weight of up to 128 kg of aluminium enables the production of ever larger structural parts, such as large battery housings for electric vehicles or so-called megacastings like the complete rear or front underbody of a car.

The completion of the conversion at the Biberach site and the commissioning of the Carat 610 extended is scheduled for 2023.

Wolfgang Schmidt (Chairman of the Board, Light Metal Casting division): “The automotive world is changing faster than it was assumed just a few years ago. The trend is clearly towards alternative drives. We as Handtmann, with our teams of experts, face these challenges of change with for example battery-electric vehicles and their complex requirements for the light metal casting component geometry such as megacasting.”

Heiko Pfeiffer (Managing Director Production, Light Metal Casting division): ‘If a construct consisting of many individual parts is to be replaced, the strengths of a megacasting component become particularly apparent in this context. Through the implementation of complex geometries and the integration of multiple functions, the megacasting component fulfils the sum of the requirements of the substituted individual parts.’

Dirk Seckler (Managing Director Sales and Technical Development, Light Metal Casting division): ‘We recognized early on that we had to transform ourselves from a pure ‘built-to-print’ company to an innovative competence and solution provider. This also includes actively shaping the transformation through innovation. By entering the megacasting business, Handtmann is once again a pioneer in the industry. We are glad to be going down this path together with our customers and the Bühler AG.’ ■

制造工艺，使得二者相结合形成了最佳组合。通过采购具有 61,000kN 锁模力和压射高达 128kg 铝合金的布勒 Carat 610 压铸机，可以生产更大的结构部件，如电动汽车的大型电池外壳，以及生产所谓的特大型铸件，如汽车的后半部分或汽车的前车身底板。

比伯拉赫工厂的改造完成和 Carat610 升级版的调试计划于 2023 年完成。

轻金属铸造部门董事会主席 Wolfgang Schmidt 这样评价：“汽车行业的变化速度比几年前能想象到的要快得多。目前的趋势明显是在寻求对驱动方式的替代。汉特曼公司与我们的技术专家团队一起面对这些变革挑战，例如电池驱动的电车及其对轻金属铸造部件几何形状（如大型一体化压铸）的复杂要求。”

轻金属铸造部门生产总经理 Heiko Pfeiffer 这样评价：“如果在结构方面，我们寻求替换由许多单独零件组成的部件，那么在这种目标下，大型压铸组件的优势变得尤为明显。通过实施复杂的几何形状和集成多种功能，大型压铸组件满足了替代单个零件的要求。”

轻金属铸造部门销售和技术开发总经理 Dirk Seckler 认为：“我们很早就已经意识到，我们必须将自己从一家纯粹的“按图纸制造”的公司转变为一家拥有创新能力、提供解决方案的供应商。这也指的是通过创新积极塑造转型。通过开拓大型压铸业务，汉特曼公司再次成为行业的先驱。我们很高兴能与我们的客户，以及合作伙伴布勒股份公司一起迈上这条新路。” ■

Kurtz Low-Pressure Casting Machine for Heunisch Site Krásná

Heunisch Krásná 公司安装新 Kurtz 低压铸造机

As a traditional family business with more than 40 years of foundry experience, Heunisch decided to invest in a new Kurtz casting line at the aluminum site in the Czech Republic in order to be best prepared for the future.

This decision for a system supplier was well-considered and based on a detailed evaluation process in advance. Heunisch was already using older Kurtz low-pressure casting machines, which, however, were no longer state of the art.

With the new casting line concept including the integrated furnace management system and shuttle, the company with headquarters in Bad Windsheim and further locations in Steinach (Thuringia), Krásná and Brno (both Czech Republic) has laid the foundation for good castings. The complete concept of the casting line with high flexibility, fastest furnace change and best melt quality as well as easy expansion of the production capacity convinced Heunisch.

Long casting without changing the furnace again

The large crucible furnace with a capacity of 2.8 t allows both: long continuous casting without changing the furnace again and extremely high flexibility for positioning the riser tubes at the same time. Whether multiple cavities or large structural components - the large furnace allows the riser tubes to be positioned exactly where they are needed.

The concept with the shuttle also allows the downtime of the machine to be reduced to a minimum, which benefits OEE. The furnace is prepared outside the machine with the best melt quality, and the actual changeover is realized in the machine's off-time - true to the motto "the machine has to run to make money".

To further increase efficiency, the casting machine has two mould change systems so that a new mould can be prepared on one and the old one dismantled in parallel on the other. The cooling system is connected via multi-couplings, which saves time and also means error-proofing when connecting the numerous cooling systems.

Complete casting solution from a single source

In combination with the latest machine innovations, such as the cooling technology developed in-house by Kurtz, the best mechanical properties are achieved and the cycle time is significantly reduced. Thanks to the highly precise pressure control, low-turbulence mould filling is implemented, producing castings of the highest quality standards. Heunisch wanted much more than just the best machine technology - the company wanted a complete solution from melt preparation to handling and casting from a single source. In the end, the entire Kurtz know-how with the complete solution for the new casting line and the years of good cooperation convinced Heunisch all along the line. ■

作为一家拥有 40 多年历史的传统家族企业，Heunisch 公司决定在捷克的铸铝厂安装一条新的 Kurtz 铸造生产线，为未来做最好的准备。

选择系统供应商的决定经过了充分考虑，并事先进行了详细评估。Heunisch 公司已经安装过 Kurtz 低压铸造机，但这些机器已不再是最先进的。

Kurtz 公司总部位于德国巴特温茨海姆，另外还有位于德国图林根州施泰纳克、捷克的 Krásná 和布尔诺的工厂，凭借包括综合熔炉管理系统和运输系统在内的新铸造生产理念，为生产优质铸件奠定了基础。Kurtz 铸造生产线的完整概念具有高度的灵活性、最快的换炉速度和最佳的熔体质量，以及易于扩大的生产能力。

长时间浇铸，无需更换熔炉

容量为 2.8t 的大型坩埚炉既可以实现长时间的连续铸造，又无需再次更换熔炉，同时具有极高的灵活性，可以定位升液管。无论是多个腔体还是大型结构部件，大型熔炉都可以将升液管准确定位。

运输系统的工作原理还允许将机器的停机时间减少到最小，有利于提高设备综合效率 (OEE)。炉子在机器外部，具有最佳的熔体质量，实际的转换是在机器的停机时间完成的——这符合“机器必须运转才能赚钱”的格言。

为了进一步提高效率，浇注设备有两个更换铸型的系统，以便在一个换型设备上准备新铸型，同时在另一个换型设备上换下原来的铸型。冷却系统通过多个耦合器连接，节省了时间，也意味着在连接多个冷却系统时可以防止出现错误。

单一来源的完整铸造解决方案

结合最新的机器创新，如 Kurtz 开发的内部冷却技术，可获得最佳机械性能，并能显著缩短循环时间。由于高度精确的压力控制，可进行低湍流充型，从而生产出最高质量标准的铸件。Heunisch 公司需要的不仅是最好的机器设备，还想要从单一来源获得从熔体准备到熔炼和铸造的完整解决方案。基于与 Kurtz 公司多年的良好合作，Heunisch 公司始终坚信 Kurtz 公司的专有技术与全新铸造生产线的完整解决方案。■

Volvo Group Launches the First Green Castings for its Engines Globally, Developed & Sourced from India

沃尔沃集团在全球推出首款绿色铸件，研发和设计均来自印度

Volvo Group is committed to becoming a climate-neutral company by 2040, this includes its supply chain & global suppliers from India. As a key milestone in this journey, Volvo Group in India launched the First Green Castings that will go into building its engines. This is a significant step as India is a key source for Volvo Group's global casting requirements. When fully adopted, the potential reduction in CO2 per year due to Green Castings would amount to 0.86 million tons for Volvo & 210 million tons for the industry. Commercial Production of these green castings will start this month.

The green castings from India will include bearing caps and bearing housing for select Volvo engines. This is the first step. However, just these two parts translate to 8500 Tons CO2 reduction for Volvo. When fully implemented, the impact of this initiative would be much higher. Assuming the industry adopts this approach, this could amount to 210 million tons of annual CO2 emission reductions across Global Foundries. This is of special significance to India, which has a significant share of the global casting demand.

The castings being produced in India are certified by the Confederation of Indian Industry – Green Products & Services Council. As per the definition, the manufacturing of Green Casting involves the elimination of toxic chemicals and elements, has zero carbon footprint, uses minimal resources, where products can be recycled and reused, and comes with eco-friendly packaging.

These Green Castings, which will be produced by Brakes India, utilize scrap, alloys, and raw materials which are 100% radioactive elements free. It involves recycling of 100% metallic scrap generated by other industries to manufacture a usable product. The plant will operate on 100% green power from solar and wind energy. It will eliminate the use of diesel with an Electric Ladle Preheater, a unique solution developed with AFECO India. This will also result in the elimination of pig iron, which is produced in a blast furnace with coal. Volvo has developed a unique technology that eliminates the Pig Iron usage by deploying Zirconium-based inoculation, controlled chemistry, and a specific charge ratio.

Speaking at the occasion, Kamal Bali, President & Managing Director, Volvo Group in India, said, "At Volvo Group, we are proud to be playing a vital role in shaping the future of the transportation industry. India is a home base for the Group and we not only 'Make in India', but also design,

沃尔沃集团承诺将于 2040 年成为一家气候中和公司，其中包括其供应链和来自印度的全球供应商。作为这一行动中的重要里程碑，沃尔沃集团近期在印度推出了第一批绿色铸件，用于发动机制造。这是一项重要举措，因为印度是沃尔沃集团全球铸件需求的主要来源。如果完全采用绿色铸件，今后每年将可能为沃尔沃减少二氧化碳排放量 86 万 t，为整个行业减少碳排量约 2.1 亿 t。这些绿色铸件的商业化生产将于本月正式启动。

这些绿色铸件在印度设计开发，涵盖了用于指定给沃尔沃发动机生产的轴承盖和轴承座。这虽然仅是计划的第一步，但就这两个部件就可以为沃尔沃减少 8500t 二氧化碳排放量。如果全面实施后，这一举措的影响会大得多。假设汽车行业采用这种生产方法，将可为全球铸造产业每年减少 2.1 亿 t 二氧化碳排放量。这对于在全球铸造需求中占有重要份额的印度来说具有特殊的意义。

在印度生产的这些绿色铸件已通过印度工业联合会 --- 绿色产品和服务委员会的认证。绿色铸件的定义指的是，绿色制造涉及消除有毒化学物质和元素，零碳足迹，保证最少的资源消耗，产品可以回收和再利用，并配有环保包装。

这些绿色铸件将由 Brakes India 负责生产，使用 100% 不含放射性元素的废料、合金和原材料。它涉及回收其他行业产生的 100% 金属废料以制造可用产品。该工厂将使用来自太阳能和风能的 100% 绿色电力，并将通过电动钢包预热器消除柴油的使用，这是与 AFECO India 共同开发的独特解决方案。这一生产过程也将导致生铁的淘汰，生铁是用煤在高炉中生产的。沃尔沃开发了一项独特的技术，通过部署基于锆的孕育剂、受控化学物质和特定的装料比来消除生铁的用量。

沃尔沃集团印度总裁兼董事总经理卡迈勒·巴厘在会上发表讲话指出：“在沃尔沃集团，我们很自豪能够在塑造交通运输行业的未来方面发挥重要作用。印度是集团的大本营，我们不仅‘印度制造’，还从印度设计、加工、销售和

process, sell and source from India to the world. In line with our global sustainability targets and ambitions, our aim is to create an environment that is safe and sustainable for future generations – while being immersed in advanced technology that goes into making world-leading commercial vehicles. Green Casting has the potential to kick-start a revolution in the casting manufacturing process for a sustainable future.”

Present at the launch of the Green Castings were Kamal Bali, President & Managing Director, Volvo Group in India; Marc Delobelle, Head of Fossil-free Materials Purchasing, Volvo Group, France; Girish DM, Head of India Purchasing & Group Truck Purchasing, Volvo Group, India; Sriram Viji, Managing Director, Brakes India; along with Parasuraman Ramachandran, Founding Chairman Green Products & Services Council, CII Godrej GBC, and Devendra Jain, President, Institute of Indian Foundrymen.” ■

运送产品到世界各地。根据我们的全球可持续发展目标和雄心，我们的目标是为子孙后代创造一个安全和可持续的环境，同时在制造世界领先商用车的过程中一直保持最先技术的应用。绿色压铸生产有可能在铸件生产过程中掀起一场革命，以实现可持续的未来。”

出席绿色铸件发布会的有沃尔沃集团印度总裁兼董事总经理 Kamal Bali、法国沃尔沃集团无化石材料采购主管 Marc Delobelle、印度沃尔沃集团印度采购和集团卡车采购主管 Girish DM、Brakes India 董事总经理 Sriram Viji，以及 CII Godrej GBC 绿色产品和服务委员会创始主席 Parasuraman Ramachandran 和印度铸造协会主席 Devendra Jain 等行业领袖们。” ■

Wheelabrator Releases 4th Digital Tool to Help Machines Run Smoothly

维尔贝莱特发布第四款数字工具

Wheelabrator has launched a new digital tool that tracks and displays the overall effectiveness of a shot-blast machine in its wider production context.

It enables operators to identify issues and bottlenecks that cause their blast machines to run below optimum, with a view to continuously perfect production and save time, money and resources.

The new tool is particularly useful in highly integrated settings with inline shot-blast machines (i.e. advanced moulding lines), where all parts of the line have to be in tune with one another to achieve maximum performance and efficiency.

The tool, called “Machine Effectiveness”, was developed in conjunction with our Digital Lab on the group’s equipment-agnostic IIoT platform, Monitizer.

It is the fourth digital tool to be launched by Wheelabrator, all designed to tackle the biggest challenges and cost drivers of running shot-blast equipment.

Heinrich Dropmann, Senior Vice President Global Wheel at Wheelabrator explains: “Most blast machine operators currently have no easy way of tracking their machine’s operating mode. They don’t have an overview of periods of downtime or idle time and their causes, whether it’s faults, delays at the point of loading/unloading, maintenance or breaks.

That means they can’t compare the efficiency of different product runs or shifts, or pinpoint where something’s not running

维尔贝莱特推出了一款新的数字工具，可以在更广泛的生产环境中跟踪和显示抛丸机的整体效率。

它可以使操作员能够识别导致抛丸机运行低于最佳状态的问题和瓶颈，从而不断完善生产，节省时间、资金和资源。

这款新工具与在线抛丸机（既有造型线）高度集成的环境中特别有用，在这种环境中，生产线的所有部分必须相互协调，以实现最大的性能和效率。

这款工具名为“Machine Effectiveness”，是与我们的 Digital Lab，在集团不受设备限制的 IIoT 平台 Monitizer 上共同开发。

这是维尔贝莱特推出的第四款数字工具，旨在解决运行抛丸设备的最大挑战和成本驱动因素。

维尔贝莱特全球抛丸高级副总裁 Heinrich Dropmann 解释道：“目前，大多数抛丸机操作员没有简单的方法来跟踪设备的运行模式。他们无法了解停机时间或闲置时间及其原因，无论是故障、上下料点延迟、维护还是中断。

这意味着他们无法比较不同产品运行或班次的效率，也无法查明哪里运行不畅以及原因。我们的新工具使他们能够即时

smoothly and why. Our new tool gives them instant access to all of this information to identify bottlenecks, reduce idle time and operate the machine ever more efficiently and productively. It can be retrofitted really easily for an instant performance boost.”

To deploy this or any of its other digital tools, Wheelabrator can digitally enable virtually any type of shot-blast machine, new or old, using its NoriGate data gateway and Monitizer | DISCOVER software. ■

访问所有这些信息，以识别瓶颈、减少闲置时间，更高效、更富有成效地操作设备。该工具可以非常容易地进行改造，立即实现性能提升。”

部署了这款或任何其他数字工具，维尔贝莱特可以使用其 NoriGate 数据网关和 Monitizer | DISCOVER 软件，实现几乎所有类型的抛丸机的数字化，无论新旧。■

Regional Experts Support 3D Printing Adoption in Foundries around the World

本地化专家为全球铸造厂采用 3D 打印技术提供支持

Binder jetting technology, where an industrial printhead selectively deposits a liquid binding agent onto a thin layer of powder to build a solid part one layer at a time, is widely regarded as the fastest additive manufacturing method for production-volume output. Sand 3D printing is sometimes referred to as indirect additive manufacturing because the sand print is used as the tooling to create a metal component, as opposed to directly 3D printing the end-use metal part.



粘结剂喷射成形技术是一种由工业打印头选择性地液体粘结剂涂覆在薄层的粉末上，一层一层铺设，生产出固体零件的技术，被广泛认为是实现批量生产的最快的增材制造方法。砂型 3D 打印有时被称为间接增材制造，因为砂型打印设备被用作创建金属部件的砂型，而不是直接 3D 打印最终使用的金属部件。

世界各地的铸造厂使用该技术已经有二十多年了，粘结剂喷射 3D 打印

Used by foundries around the world for over two decades, binder jet 3D printing sandcasting molds and cores straight from CAD files offers transformational benefits, from faster delivery times by eliminating the months-long lead times of and high costs of traditional patterns and core boxes to advancing the complexity of cast components through new design freedoms that optimize products.

But because the sand 3D print serves as a tool it is important to not only understand the 3D printing process that makes the tool, but also the casting process for which the tool will be used. For this support, it's essential for ExOne to have regional experts available to foundries around the world.

的砂型和型芯直接来自 CAD 文件，从缩短交付时间（不需要长达数月的传统铸型和型芯盒的交付周期和高昂的成本）到通过优化产品的设计自由度提高铸造组件的复杂性，都有了巨变。

但是，由于砂型 3D 打印设备是作为一种工具，因此，重要的是不仅要了解 3D 打印设备的制作原理，还要了解它的工作过程。ExOne 公司必须向世界各地的铸造厂提供本地专家服务，使他们得到相应的支持。

成立于 2005 年的 ExOne 日本应用中心（EAC），旨在



Founded in 2005, the ExOne Adoption Center (EAC) in Japan aims to introduce and expand the sand 3D printing technology. “Outside the U.S., Asia has the greatest number of foundries in the world,” said Ben Leung, Vice President of Asia for Desktop Metal, which acquired ExOne in 2021. “Having the adoption center in Japan with the capacity to print parts and share the knowledge of our binder jetting experts enables us to support this network of key players. We aim to empower foundries throughout Asia Pacific with additive manufacturing technology to adapt to the challenges they face today and speed up their time to market.”

Ken Yokoyama, Director of ExOne in Japan, partners with foundries adopting 3D printing and believes offering local support is necessary to help risk-adverse companies embrace a new technology. “It’s important to have confidence that you’ll be supported by a regional technical team,” Yokoyama says, who’s been with ExOne for nearly two decades working with leading customers in the automotive industry.

Comprehensive support at the adoption center ranges from CAD design consultation and local material sourcing to 3D printing production and field service of customer machines. “Our facility features three sand 3D printers utilizing furan and phenolic binders for benchmarking, material and application development, as well as production services,” Yokoyama explained.

Yokoyama and the ExOne EAC in Japan worked closely with Kimura Group, for example, to tailor its sand binder jet 3D printing process to use the foundry’s patented ceramic sand. The team focuses on the final part to understand the requirements; the team needs to understand the chemistry and physics at work during the metalcasting process to select the right materials and ensure success for the customer.

ExOne is committed to providing regional experts to support the adoption of additive manufacturing 2.0 so foundries around the world can benefit innovative sand binder jet technology. ■

介绍和推广砂型 3D 打印技术。“在美国以外的其他地区，亚洲拥有世界上数量最多的铸造厂，” Desktop 金属公司亚洲区副总裁 Ben Leung 表示，该公司于 2021 年收购了 ExOne 日本公司。“在日本有一个应用中心，能够打印零件并分享我们的 3D 打印知识，这使我们能够支持这一关键市场的参与者。我们的目标是整个亚太地区的铸造厂提供增材制造技术，以适应他们今天面临的挑战，加快其产品的面市时间。”

ExOne 日本公司的董事 Ken Yokoyama 与采用 3D 打印的铸造厂合作，他认为提供本土化技术支持是必要的，有助于帮助迎接风险挑战的公司接受新技术。Yokoyama 表示：“有信心得到本地技术团队的支持，这一点很重要。”他在 ExOne 公司工作了近 20 年，与汽车行业的领先客户进行了合作。

应用中心包含了全面的支持服务，从 CAD 设计咨询、本地材料采购到 3D 打印生产和客户机器的现场服务。Yokoyama 解释说：“我们的工厂配备了三台砂型 3D 打印机，使用呋喃和酚醛粘合剂进行基准测试、材料和应用开发以及生产服务。”

例如，Yokoyama 和日本 ExOne EAC 及木村集团密切合作，定制其砂型粘结剂喷射 3D 打印工艺，以使用该铸造厂的专利陶瓷砂产品。团队关注最终部件的需求，需要了解金属铸造过程中的化学和物理工作原理，以选择正确的材料，确保客户取得成功。

ExOne 公司致力于为客户提供本地化的专家服务，支持增材制造 2.0 的技术应用，使世界各地的铸造厂能够受益于创新的砂型粘结剂喷射技术。■

Charlotte Pipe and Foundry Acquires Neenah Enterprises

夏洛特铸管公司收购尼纳公司

AFS Corporate Member Charlotte Pipe and Foundry Co. (Charlotte, North Carolina) purchased AFS Corporate Member Neenah Enterprises, Inc., (Neenah, Wisconsin) effective July 13. Neenah's plants in Medley, Florida, Neenah, Wisconsin, and Lincoln, Nebraska, manufacture construction and industrial castings. Neenah has been operating in the construction castings industry for 150 years.

"This acquisition in an adjacent sector builds on our core competency in the manufacturing of grey iron castings," said Hooper Hardison, president and CEO of Charlotte Pipe and Foundry Co. "We believe that Charlotte Pipe's financial strength and manufacturing expertise will strengthen Neenah's portfolio."

Charlotte Pipe and Foundry Co., established in 1901, is a privately-held corporation operating seven plants across the U.S. that produce plastic pipe and fittings, cast iron soil pipe and fittings used primarily for drain, waste, and vent purposes, as well as commercial castings. The company is currently constructing a new greenfield foundry operation east of Charlotte, which will come on-line in the third quarter of 2023. ■

美国铸造协会会员企业夏洛特铸管公司（北卡罗来纳州夏洛特市）收购了美国铸造协会会员企业尼纳企业集团（威斯康星州尼纳市），于7月13日生效。尼纳公司在佛罗里达州梅德利、威斯康星州尼纳市和内布拉斯加州林肯市的工厂生产建筑和工业用铸件。尼纳公司从事建筑用铸件生产已有150年历史。

夏洛特铸管公司总裁兼首席执行官 Hooper Hardison 表示：“这两个相近行业的收购建立在我们的灰铸铁件制造方面的核心竞争力的基础上。我们相信，夏洛特铸管公司的资金实力和制造能力将增强尼纳公司的产品组合。”

夏洛特铸管公司成立于1901年，是一家私营公司，在美国经营7家工厂，生产主要用于排水、排污和通风系统的塑料管和配件、铸铁污水管和配件，以及商业用途铸件。该公司目前正在夏洛特东部新建铸造厂，预计将于2023年第三季度投产。■

Ferroglobe and Rec Silicon Join Forces to Develop U.S. Integrated Solar Supply Chain

Ferroglobe 公司和 Rec Silicon 公司 联手开发美国集成太阳能供应链

Ferroglobe PLC, a producer of silicon metal, silicon-based alloys, and manganese-based specialty alloys, announced a memorandum of understanding (MOU) with REC Silicon in which Ferroglobe commits to leverage its asset platform in the U.S. to supply high purity silicon metal to REC Silicon aimed at jointly establishing a low-carbon and fully traceable U.S.-based solar supply chain.

Recent investment by the Hanwha Group into REC Silicon, in conjunction with Hanwha Group's subsidiary Qcells, has sparked the impetus to expand REC Silicon's long-standing relationship with Ferroglobe and plan for the immediate development of an end-to-end U.S. solar supply chain from silicon metal, to polysilicon, all the way to fully assembled

有机硅金属制品、硅基合金和锰基特种合金的生产商 Ferroglobe 公司宣布与 REC Silicon 公司达成谅解备忘录，Ferroglobe 公司承诺将利用其在美国的资产平台向 REC Silicon 公司供应高纯度金属硅，旨在在美国共同建立一个低碳和完全可追溯的太阳能供应链。

Hanwha 集团及其子公司 Qcells 公司共同对 REC Silicon 公司进行了投资，激发了 REC Silicon 与 Ferroglobe 公司开展长期合作的动力，并计划立即开发端到端的美国太阳能供应链，从金属硅、多晶硅，一直到完全组装的太阳能模块。该项目产生的影响将辐射从华盛顿州到

solar modules. The impact of such a project would span from Washington State to Georgia, West Virginia, and beyond.

According to a Ferroglobe press release, passage of Senator Jon Ossoff's Solar Energy Manufacturing for America Act as part of a broad clean energy incentive package would make such plans immediately possible.

Ferroglobe stated it will be a critical partner in ensuring steady supply of fully traceable metallurgical grade silicon metal produced in the U.S. from locally sourced raw materials and utilizing its highly skilled domestic workforce. Ferroglobe said it is one of the world's largest producers of silicon metal and seeks to leverage its technical and operational expertise across sites in West Virginia, Alabama, and Ohio to support this effort. ■

乔治亚州、西弗吉尼亚州及其他地区。

据 Ferroglobe 公司报道，参议员乔恩·奥索夫的美国太阳能制造业法案作为广泛的清洁能源激励计划的一部分，将使此类计划立即成为可能。

Ferroglobe 公司表示，它将成为从当地采购原材料并利用其高技能国内劳动力，在美国生产完全可追溯的冶金级金属硅的关键供应商合作伙伴。Ferroglobe 公司表示，它是世界上最大的金属硅生产商之一，将利用其在西弗吉尼亚州、阿拉巴马州和俄亥俄州的技术和生产优势来支持这项合作。■

Linamar's New 'Medtech' Group to Focus on Medical Devices and Precision Medical Components

利纳马集团新成立的 Medtech 公司将专注于医疗设备和精密医疗组件

Ontario-based Linamar Corp. has formed a new medical manufacturing group, MedTech, which will focus on leveraging its expert capabilities in precision manufacturing to pursue opportunities in the medical device and precision medical component markets.

The company said MedTech will further fuel growth and diversification in line with Linamar's 2100 strategy. The announcement builds on the medical device programs the company has launched over the past several years, including full ventilator systems and ventilator parts, part of the highly critical, expedited launch effort in response to the public health crisis created by the COVID-19 pandemic. Linamar has also successfully launched other medical device programs in automated robotic microscopy.

"Linamar has expertise and resources that are applicable beyond the markets in which it operates today as we have proven with prior diversification initiatives," said Linda Hasenfratz, Linamar's Executive Chair and CEO. "With a growing and aging population, the medical device and precision components market is one that is growing quickly. This is an exciting new area for Linamar to grow, and one in which we have already proven we can excel."

By utilizing the Linamar global operating structure and manufacturing footprint, Linamar plans to manufacture precision medical components and complex medical device assemblies for the global medical market. Potential targeted products include surgical, respiratory, and imaging devices, and precision components for devices, orthopedics, and prosthesis. ■

总部位于加拿大安大略省的利纳马公司成立了新的医疗制造公司 MedTech，将专注于利用其在精密制造方面的专业能力，在医疗设备和精密医疗部件市场寻求发展机会。

根据利纳马集团 2100 战略，MedTech 公司将进一步推动增长和多元化。这一声明是建立在公司过去几年推出的医疗设备项目的基础上，包括全呼吸机系统和呼吸机部件，这是应对 Covid-19 大流行造成的公共卫生危机，做出的非常关键、加速发展的部分努力。利纳马集团还成功地推出了自动机器人显微镜中的其他医疗设备程序。

利纳马集团执行主席兼首席执行官琳达·哈森弗拉茨说：“利纳马集团拥有足够的专业知识和资源，正如我们之前的多元化计划所证明的。随着人口的增长和老龄化，医疗设备和精密零部件市场正在快速增长。这是利纳马集团成长的一个令人兴奋的新领域，事实证明我们可以脱颖而出。”

通过利用利纳马集团的全球运营结构和生产足迹，利纳马集团计划为全球医疗市场制造精密的医疗组件和复杂的医疗设备组件。目标产品包括外科、呼吸和成像设备，以及矫形外科和假肢的精密组件。■

Craft Pattern & Mold Acquires its Fourth and Largest 5-Axis Machining Center

Craft 公司安装第四台暨最大的五轴加工中心

AFS Corporate Member Craft Pattern & Mold, a manufacturer of prototype machined castings in Montrose, Minnesota, has installed the second-largest 5-axis machining center made by Haas. The UMC1250 has a 50-in. work envelope, expanding the company's ability to prototype large, tight-tolerance castings with a single workholding setup, which translates into cost and time savings for customers.

"The five-axis family of machines really helps us leverage a lot of the advantages of single setups to do complex parts and to hold tighter geometry and tighter tolerances", said General Manager Steve Shade. "That's where the real benefit is. For larger iron, steel, and aluminum castings, where we used to have to have multiple fixtures and programs and different setups in order to finish out the parts, now we can do it in a single holding."

In 2021, Craft Pattern & Mold was chosen to prototype a small volume of tight-tolerance government castings for a Defense project—and while they achieved the requirements, the company did so less efficiently than it wanted, said Shade. Thus began the vision to add the UMC 1250.

"This customer is looking at a follow-on order this year, and we saw the need to get better at how that process rolls from a part of the size we had," he said. "It really fits this machine quite nicely. So that was one of the big catalysts for the purchase. And we've got other parts as well, where, we're always thinking, 'Hey, wouldn't it be nice if we just had a few more inches here and few more inches there?' Everything we're making is just getting bigger and bigger."

A dwindling skilled-labor market was the other major driver for the latest capital investment. "Trying to find people who understand how to deal with castings has always been a challenge," Shade said. "It's one of the things in the machining world that we run into, especially with people who are new to castings—just understanding parting lines and draft and some of the issues you have to deal with when trying to machine a casting versus a solid piece of material you buy off the shelf. The UMC1250 helps move us along, because we can get into a job, get machining, and start moving on to the next project faster."

For the uptick in subcontracted prototype work for production foundries over the last 18–24 months—which are backlogged six months and longer—the faster turnaround is good news, helping remove bottlenecks to get foundry customers what they need prior to production. Reduced setups and fixtures not only expedite parts machining, Shade added, but also translates into a more cost-effective process.

"With material pricing, energy, labor, subcontract costs—

位美国铸造协会会员企业 Craft 造型及模具公司是位于明尼苏达州蒙特罗斯的一家原型及铸件加工企业。公司安装了哈斯数控的第二大五轴加工中心，该 UMC1250 加工中心为 50 英寸的工作行程，扩大了公司使用单个工装夹具制造大型、紧公差原型铸件的能力，为客户节省了成本和时间。

"五轴系列设备的确帮助我们利用单一设置的优势来生产复杂零件，满足复杂几何形状和严格公差的要求，" 公司总经理史蒂夫·夏德说，"这就是真正的优势所在。对于较大的铸铁、铸钢和铝铸件，我们过去必须使用多个夹具、应用程序以及不同的设置才能完成，现在我们保持同一设置就可以完成。"

夏德表示，2021 年，Craft 公司接到一个政府订单，需要为一个国防项目制作小批量紧密公差铸件的原型，虽然 Craft 公司可以满足铸件生产的要求，但生产效率低于预期。于是，公司开始进行 UMC 1250 的购置计划。

他说："该客户正在考虑跟进新的订单，我们认为有必要更好地了解这一订单的工艺，从而使我们脱颖而出。这台机器是非常适合的，这是促使我们选择它的催化剂。我们还有其他铸件订单，我们总是在思考，'嘿，如果这个部位多几英寸，那个部位多几英寸不是更好吗？' 我们正在制造的一切都在变得越来越大。"

技术工人劳动力市场的萎缩是这项最新投资的另一个主要驱动力。夏德说："寻找精通铸件生产的人一直是一个挑战。这是我们在机械加工领域遇到的困难之一，尤其是对铸件不熟悉的人来说，例如，在加工铸件时需了解分型线和拔模，以及必须处理的一些问题，而不是从货架上购买成品那么简单。UMC1250 对我们有很大的帮助，我们可以启动一项新的工作、进入加工作业，并可以快速进入到下一个项目。"

在过去的 18–24 个月中，生产型铸造企业的分包原型件生产业务上升，有的积压了 6 个月或更长时间，因此，更快的周转时间是个好消息，将有助于消除瓶颈问题，让客户在生产之前得到他们需要的东西。夏德补充说，减少设备的设置和夹具的使用，不仅可以加快零件加工，还可以转化为更具成本效益的生产。

夏德说："随着原材料、能源、劳动力、分包成本的上涨，一切价格都在飙升。我们每周都会收到涨价的通知邮件。因此，

everything's going through the roof," said Shade. "We're getting price increase letters every week. We need to find ways to be more efficient with our labor—bringing in more automation helps reduce the labor requirement and helps us, as an American manufacturer, to help stay competitive." ■

我们需要找到更高效的工作方式，引入更多的自动化技术有助于减少劳动力需求，并帮助我们保持竞争力。” ■

Kimura Foundry America Starts Aluminum Casting

木村铸造美国公司开展铸铝业务

Kimura Foundry America, Inc. (KFA) (Shelbyville, Indiana) announced it has installed a new, 440-lb. aluminum melting furnace and has started aluminum casting. The company has been producing iron and steel castings using 3D sand printers with artificial sand since it was established in November 2018.

While meeting customers' demand for iron and steel castings, KFA found that many of these customers also have a need for aluminum with quick turnaround times. This, coupled with the growing demand for aluminum castings from the automotive, aerospace, and construction machinery industries, motivated KFA to make the investment in the new furnace.

KFA still serves customers who desire gray and ductile iron as well as various other ferrous material such as heat-resistant Ni-resist casting, stainless steel, compacted graphite iron (CGI) and many other special alloy castings based on customers' specifications. ■

位于印第安纳州谢尔比维尔的木村铸造美国公司 (KFA) 宣布已安装了熔炼能力为 440 磅的铝合金熔炼设备，并已开始铝合金铸件生产。自 2018 年 11 月成立以来，该公司使用 3D 砂型打印设备和人造砂生产铸钢及铸铁件。

在满足客户对铸钢铸铁件需求的同时，KFA 公司发现许多客户需要快速生产的铝合金铸件。加上汽车、航空航天和工程机械行业对铝铸件的需求不断增长，促使 KFA 公司投资购买新的熔炉。

KFA 公司继续为灰铸铁、球墨铸铁以及各种黑色金属铸件的客户提供服务，例如耐热镍合金铸件、不锈钢、蠕墨铸铁 (CGI) 及客户定制规格的其他特殊合金铸件。■

Vesuvius Ups Investments in Manufacturing, Innovation, and Sustainability

维苏威公司增加在制造、创新和可持续性方面的投资

Through its Foseco brand, Vesuvius is investing in manufacturing and engineering initiatives throughout North America that: reduce customer lead time, deliver continued product innovation, and offer sustainable consumables and solutions for customers to reduce their environmental footprint.

Construction has begun on a new state-of-the-art manufacturing facility, where 75% of customer demand in North America will be fulfilled beginning in 2023. The new location and existing facilities are being outfitted with updated technology and sustainable initiatives that reduce carbon emissions and improve overall speed and delivery of production processes. The company acquired Universal Refractories Inc., which significantly expands its North American presence among electric-arc furnace (EAF) steel producers, while further strengthening its commitment to foundry customers in the region. ■

为减少交货时间，保持产品的创新，并为客户提供可持续的消耗品和解决方案，减少他们的碳足迹，维苏威公司正通过其福士科品牌，在整个北美的制造和工程项目上注资。

使用最先进技术的新工厂已经开始建设，从 2023 年起将满足北美客户 75% 的需求。新工厂和现有设施正在配备更新的技术和可持续的举措，以减少碳排放，提高生产过程的整体速度和交付。公司收购了通用耐火材料公司，此举显著扩大了公司在使用电弧炉 (EAF) 作业的北美钢铁生产商中的业务，同时进一步强化了对该地区铸造客户的承诺。■

Steel Dynamics to buy Mexican Metals Recycler

Steel Dynamics 公司计划收购墨西哥金属回收公司

Steel Dynamics, Inc., one of the largest U.S. steel producers and metals recyclers, recently announced its planned acquisition of ROCA, a Mexican recycling company in a cash-funded deal. ROCA's primary operations are comprised of four scrap processing facilities, strategically positioned near high-volume industrial scrap sources located throughout Central and Northern Mexico. These combined facilities currently ship approximately 575,000 gross tons of scrap annually and have an estimated annual processing capability of approximately 850,000 gross tons.

"We look forward to adding ROCA to the Steel Dynamics family to further solidify our Southwest U.S. and Mexico growth strategy," said Mark D. Millett, chairman, president and chief executive officer.

"Combined with our existing North American metals recycling facilities, the addition of ROCA significantly strengthens our raw material procurement strategy in the region. After closing the ROCA transaction and fully integrating our Mexican metals recycling operations, we believe our Mexican scrap facilities will provide an even more meaningful competitive advantage to our U.S. electric-arc furnace steel operations, while also providing a high-quality, customer centered option for our outside scrap customers. We are very excited to welcome and learn from the entire ROCA team." ■

近日，美国最大的钢铁生产商和金属回收商之一 Steel Dynamics 公司宣布，将计划以现金资助的方式收购墨西哥资源回收公司罗卡公司(ROCA)。ROCA公司有4个废料处理厂，工厂专门设立在墨西哥中部和北部，那里有大量的工业废料产生。目前，每年输送到这些工厂的废料约575000t，年处理能力约为850000t。

"我们期待着在 ROCA 公司加入到 Steel Dynamics 大家庭后，将可以进一步巩固我们在美国西南部和墨西哥的发展战略，" Steel Dynamics 公司董事长、总裁兼首席执行官 Mark D. Millett 表示。

"在现有北美金属回收厂的基础上，ROCA 公司的加入将大大加强我们在该地区的原材料采购战略。在完成 ROCA 公司的收购并完全整合我们的墨西哥金属回收业务后，我们相信，公司的墨西哥金属回收厂将为我们的美国电弧炉钢铁生产注入更有意义的竞争优势，同时也为公司的其他废金属回收客户提供高质量、以客户为中心的选择。我们对 ROCA 公司的加入感到非常高兴，并向整个 ROCA 团队学习。" ■

Fundición a Presión



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CHINA'S TOTAL CASTING PRODUCTION REACHED 54.05M TONS IN 2021

2021 年中国铸件产量达到 5405 万吨

During the Seventh Forum on National Foundry Industry Innovation and Development held on July 26, the data of China's foundry industry in 2021 has been officially released by Mr. WANG Dongsheng, the newly elected Executive Vice President and Secretary General of China Foundry Association.

Total casting output

In 2021, the total output of China's castings reached 54.05 million tons, with a year-on-year increase of 4.0%, and an average increase of 5.3% in two years. The foundry industry has maintained relatively stable development.

Casting output in different materials

Gray iron: 22.55 million tons;
Ductile iron: 15.95 million tons;
Malleable iron: 600,000 tons;
Steel casting: 6.6 million tons;
Aluminum (magnesium) alloy: 7.2 million tons;
Copper alloy: 900,000 tons;
Other casting: 250,000 tons.

Casting demand of downstream industry

Automobile: 15.4 million tons;
Internal combustion engine and agricultural machinery: 5.55 million tons;
Engineering machinery: 5.2 million tons;
Mining, metallurgical and heavy machinery: 5 million tons;
Cast pipes and fittings: 8.85 million tons;
Machine tools: 2.6 million tons;
Rail transit: 2.15 million tons;
Power generation equipment and power: 2.35 million tons;
Ship building: 350,000 tons;
Other: 6.6 million tons.

The automobile industry is the largest market of castings, auto casting accounts for 28.5% in 2021's total production. Driven by exports growth, the output of automobile castings increased by 2.7% year-on-year; The demand for castings in machine tools, general machinery and emerging industries has increased, such as robots. ■

2022 年 7 月 26 日, 在第七届全国铸造行业创新发展论坛上, 2021 年中国铸造行业数据正式发布。中国铸造协会执行副会长兼秘书长王东生进行了数据发布与详细解读。

铸件总产量

2021 年中国铸件总产量达到 5405 万吨, 同比增长 4.0%, 两年平均增长 5.3%, 铸造行业实现了相对平稳的发展。

分材质铸件产量

灰铸铁铸件产量 2255 万吨;
球墨铸铁铸件产量 1595 万吨;
可锻铸铁铸件产量 60 万吨;
铸钢铸件产量 660 万吨;
铝(镁)合金铸件产量 720 万吨;
铜合金铸件产量 90 万吨;
其他铸件产量 25 万吨。

下游行业铸件需求

汽车铸件 1540 万吨;
内燃机及农机铸件 555 万吨;
工程机械铸件 520 万吨;
矿冶重机铸件 500 万吨;
铸管及管件 885 万吨;
机床工具 260 万吨;
轨道交通铸件 215 万吨;
发电设备及电力铸件 235 万吨;
船舶铸件 35 万吨;

其他铸件 660 万吨。汽车工业是铸件最大需求用户, 2021 年汽车铸件占比为 28.5%, 由于出口的拉动作用, 汽车铸件产量同比增长 2.7%; 机床、通用机械及新兴产业如机器人等领域铸件需求增加。■



The Situation of Pakistan Foundry Industry

Pakistan Foundry Association

巴基斯坦铸造行业现状

巴基斯坦铸造协会

Casting output and foundries

There are about 1530 foundries in Pakistan, out of these foundries, their production capacity is 400,000 tons and the current production is 250,000 tons. Bulk of production is basically castings in MS steel, Gray iron, Ductile iron and non-ferrous etc.

The Foundry industry of Pakistan is engaged in the production of automotive parts, tractors, sugar mills machinery parts, cement factories consumables, chemical factories consumables, agriculture implements, heavy industrial castings, pumps, valves, electric motors, textile and cement machinery, processing industries and others.

Challenges

The biggest challenge of the foundry industry in Pakistan is to change in mindset for adopting new technology. The foundry industry of Pakistan seems to be suffering from a lack of awareness of new technologies & skills development of the foundry staff. We have challenges with our local foundry industry and we want international associations to guide us on the association level. We want to create awareness through technical seminars conducted by global foundry experts to teach the new foundry practices. ■

巴基斯坦铸件产量及铸造企业数量

巴基斯坦有大约 1530 家铸造厂，总产能可以达到 400,000 吨，目前的产量为 250,000 吨。主要铸件产品为玛钢、灰铸铁、球墨铸铁和有色金属等。

巴基斯坦的铸件产品主要应用于汽车零部件、拖拉机、制糖设备零部件、水泥厂耗材、化工厂耗材、农机工具、重工业、泵、阀、电机、纺织和水泥机械等加工工业领域。

挑战

目前，巴基斯坦铸造业面临的巨大挑战是急需改变旧有的思维模式，引进新的铸造技术。巴基斯坦铸造业的发展因缺乏新技术和对新技能的了解而受到很大的制约。巴基斯坦的铸造行业面临着巨大的挑战，希望国际铸造行业协会给与指导，例如通过举办有全球铸造专家参与的技术研讨会，带来新的铸造技术和实践经验，从而提高巴基斯坦铸造业对新技术的了解。

INTEGRATION OF MICROPOROSITY PREDICTION IN DURABLE AND ROBUST COMPONENT DESIGNS OF HIGHLY LOADED ALUMINUM CASTINGS

M.Sc. M. Weidt, MAGMA Gießereitechnologie GmbH, Aachen, Germany
Prof. Dr.-Ing. A. Bührig-Polaczek, Foundry Institute, RWTH Aachen University

将微观缩孔预测集成到高负载铝铸件的 耐久和稳健部件设计中

德国亚琛迈格码公司 理学硕士 M. Weidt
亚琛工业大学铸造研究所 Dr.-Ing A. Bührig-Polaczek 博士

1. Abstract

Cyclically loaded cast aluminum components continue to be subjected to strong pressure to increase power density, particularly through increased specific loads or by weight reduction. To achieve these goals, it is necessary to fully exploit the material-specific performance potential. At the same time, robust manufacturing processes require precise knowledge of the main influencing variables linking process parameters, component design, and component performance. A closed simulation chain and the systematic use of virtual test plans (DoE) promise the targeted development of components and optimized and robust production. This paper presents in detail one of the main influencing variables in the simulation chain, the relationship between the existing local porosity and the resulting defect size. In an integrated approach, the obtained information will be used to predict the local fatigue strength and combined with the residual stress state to predict the fatigue performance for an aluminum cylinder head. By validation component tests it can be shown that only this integrated approach allows a satisfactory failure prediction under cyclic loading.

2. Motivation and Background

Combustion engines are subjected to static and cyclic loads during operation. In particular, the cyclic loads that can be borne depend not only on the alloy composition and local microstructure but also to a large extent on existing microstructural defects. During the solidification of aluminum castings, it is hardly possible under real production conditions to completely avoid a certain number of property-

1. 摘要

为了提高功率密度，特别是通过增加比负载或减轻重量，循环加载的铸铝部件持续承受强大的压力。为了实现这些目标，有必要充分挖掘材料特定的性能潜力。同时，稳健的制造工艺需要准确了解连接工艺参数、部件设计和部件性能的主要影响变量。封闭的仿真链和虚拟测试计划 (DoE) 的系统使用保证了组件的目标开发以及优化和稳健的生产。本文详细介绍了模拟链中的主要影响变量之一，即现有局部孔隙率与由此产生的缺陷尺寸之间的关系。在集成方法中，获得的信息将用于预测局部疲劳强度，并结合残余应力状态来预测铝制缸盖的疲劳性能。通过验证组件测试可以表明，只有这种集成方法才能在循环加载工况下取得令人满意的失效预测。

2. 动机和背景

内燃机在运行期间承受静态和循环载荷。尤其是可以承受的循环载荷不仅取决于合金成分和局部微观组织，而且在很大程度上取决于现有的微观组织缺陷。在铝铸件凝固过程中，在实际生产条件下，几乎不可能完全避免一定数量的金属间化合物相、夹杂物或微观缩孔等降低性能的缺陷。在这些缺陷中，微观缩孔通常是微观组织中最大的局部缺陷，因此显著决定着疲劳性能。^{[1], [2]}

在减轻内燃机重量的同时提高功率密度的持续努

reducing defects such as intermetallic phases, inclusions, or micropores. Among these defects, micropores often represent by far the largest local defect in the microstructure and therefore significantly determine the cyclic properties^{[1],[2]}.

The ongoing efforts to reduce the weight of internal combustion engines while at the same time increase power density are increasingly raising the requirements for full utilization of the material's strength potential.

Design decisions have a direct impact not only on the load distribution of the component but also on the local material properties and defect distributions. Faster solidification leads to a finer microstructure formation, which is usually associated with advantageous material properties. However, design decisions can also have a negative influence on the local solidification behavior and can increase the formation of porosity, as well as cause or intensify residual stress-related casting defects such as hot tearing and cold cracks. It is of great advantage to assess the consequences of decisions regarding cast part and casting process design while still in the planning stage. At this point, the virtual design of experiments (DOE) tool is available as part of the integrated casting process simulation. By systematically working through virtual experiments, safe process windows can be identified at the design stage of the casting. The complex interactions between component design, manufacturing conditions, and unavoidable fluctuations in manufacturing become manageable by a virtual DOE.

The results presented in this paper are based on the systematic analysis of microporosity in a cylinder head using computed tomography at the micrometer scale. The goal of this work is to develop a better understanding of the relationships between porosity, pore size, and pore morphology. With this information available, a methodology to predict the local cyclic fatigue performance should be realized. The extension includes the effect of microporosity in addition to the influence of microstructure; thus it significantly improves the correct representation of the local material behavior of castings compared to the standard approach where only the local dendrite arm spacing (DAS) is considered. Moreover, it is shown that the residual stress state of the casting is a significant contributor to the actual failure behavior.

3. Casting Process

In this paper, the results of a cylinder head, manufactured by NEMAK Linz, Austria, using the Rotacast[®] process^[3], are presented. Here, the melt is transferred from the holding furnace to a tundish by an automated pouring ladle. The tundish then docks with the prepared mold from below. A 180° rotational movement around the longitudinal axis fills the mold uniformly and with low turbulence. The cylinder heads were cast using two alloys, AlSi7Cu0.5Mg and AlSi8Cu3. Both alloys are typical for internal combustion engine applications, were melted from grain refined ingots and modified by

力中，对充分利用材料强度潜力的要求越来越高。

设计决策不仅对组件的载荷分布有直接影响，而且对局部材料性能和缺陷分布也有直接影响。更快的凝固导致形成的微观组织更细小，从而获得更有利的材料性能。然而，设计决策也会对局部凝固行为产生负面影响，并可能增加缩孔的形成，并导致或加剧与残余应力相关的铸造缺陷，如热裂和冷裂。评估仍处在规划阶段的铸件和铸造工艺设计是非常有利的。此时，虚拟实验设计 (DOE) 工具可用作集成铸造工艺模拟的一部分。通过系统地进行虚拟实验，可以在铸件在设计阶段确定安全的工艺窗口。组件设计、制造条件和制造中不可避免的生成波动之间的复杂相互作用可以通过虚拟 DOE 进行管理。

本文介绍的结果基于使用微米级计算机断层扫描对缸盖中的微观缩孔进行系统分析。这项工作的目标是更好地理解孔隙度、缩孔尺寸和缩孔形貌之间的关系。了解这些关系后，就可以实现一种预测局部循环疲劳性能的方法。还可以了解微观组织和微观缩孔对局部循环疲劳性能的影响；因此，与仅考虑局部枝晶间距 (DAS) 的标准方法相比，它显著提高了铸件局部材料行为的正确预测。此外，它表明铸件的残余应力状态是实际失效行为的重要贡献者。

3. 铸造工艺

本文介绍了由奥地利 NEMAK 林茨使用 Rotacast[®] 工艺制造的缸盖的结果。在这里，熔体通过自动浇包从保温炉转移到中间包。然后中间包从下方与准备好的模具对接。围绕纵轴的 180° 旋转运动以低湍流、均匀地填充模具。使用两种合金，AlSi7Cu0.5Mg 和 AlSi8Cu3，铸造缸盖。这两种合金都是内燃机应用的典型合金，由晶粒细化的铸锭熔化并在铸造前通过添加锶进行变质。

从缸盖的三个区域取样，每个区域具有不同的凝固速率：燃烧室附近、中间甲板和凸轮轴轴承处。本测试的目的是涵盖各种凝固条件以及产生的微观缩孔。

4. 微型计算机断层扫描和数据准备

孔隙率分布和缩孔形状的分析是基于 30 个试样，每次从两种合金的缸盖上的三个位置取 5 个样（来自五个缸盖）。取样是在奥地利莱奥本大学通用机械工程系进行的。计算机断层扫描分析由奥地利莱奥本材料中心使用 GE nanotom m(XCT) 进行。根据预

strontium addition before casting.

Samples were taken from the cylinder heads from three areas, each with different solidification rates: near the combustion chamber, in the tween deck, and the camshaft bearing. The objective was to cover a wide range of solidification conditions and the resulting microporosity.

4. Microcomputed Tomography and Data Preparation

The analysis of porosity distribution and pore shapes are based on 30 specimens, five specimens each (from five cylinder heads) in three positions and with two alloys. Sampling was carried out at the Department of General Mechanical Engineering at the University of Leoben, Austria. Computed tomographic analysis was performed by the Materials Center Leoben, Austria, using a GE nanotom m (XCT). Depending on the expected microstructure fineness, a spatial resolution of $3\mu\text{m}$ voxel size (rapidly solidified samples) and $8\mu\text{m}$ voxel size (slowly solidified samples) was used (voxel size=three-dimensional equivalent to a two-dimensional pixel). At the resolution of $3\mu\text{m}$ and $8\mu\text{m}$, respectively, the scanned sample volume averages at about 144 and 477 mm^3 across all corresponding samples.

By setting a threshold value, each voxel was defined to be pore volume or dense metal. Digital image post-processing was then used to artificially increase the resolution of the resulting pore volumes. Adjacent pore volumes were "merged" and analyzed as one larger pore. The criterion for aggregation was based on the distance between two pores and their equivalent spherical diameters: If the smaller equivalent sphere diameter met or exceeded the pore spacing, the pores were combined. The analysis routine used for this purpose was developed by the Department of General Mechanical Engineering at the University of Leoben in Austria. Details of the XCT measurements and analyses, as well as the suitability of the XCT radiation source, the required spatial resolution, the required size of the scanned volume, and data processing techniques, are discussed elsewhere by Garb et al. [4]

Figure 1 shows a pore with its associated convex envelope. To characterize the size of each pore, the largest dimension of these envelopes was defined as the envelope diameter d_e . The maximum value within each sample is referred to below as the maximum envelope diameter $d_{e,max}$.

The measure of sphericity describes how far the quotient of volume to the surface area of a body deviates from that of a sphere. With the help of this quantity, the morphology of a pore can be characterized. Here, the sphericity must be within the values 1 "perfect sphere" and 0 "perfect deviation from a sphere". The sphericity of a pore is calculated using:

Here s_i and v_i are the surface area and volume of a

$$\psi_i = \frac{\frac{1}{\pi^2}(6v_i)^{\frac{2}{3}}}{s_i} \quad \text{(Equation 1)}$$

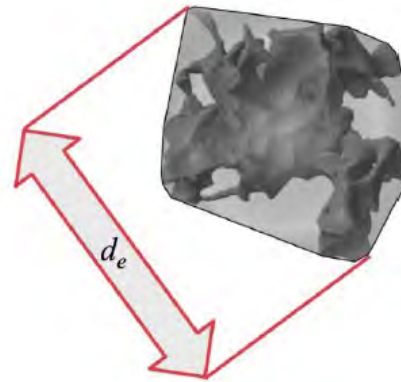


Figure 1: Representation of the largest dimension of a convex pore envelope (d_e)

图 1 : 缩孔包络体 (d_e) 的最大尺寸表示

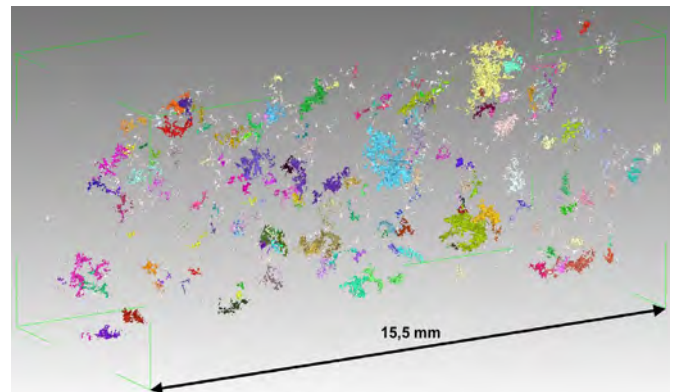


Figure 2: Three-dimensional representation of an XCT sample from the tween deck of an AlSi8Cu3 cylinder head. The porosity is 0.176%, the maximum diameter of the pore envelope is $d_{e,max}$ 2.75mm. The coloring of the individual pores is done randomly and serves only for better differentiation of the individual pores [5].

图 2 : 来自 AlSi8Cu3 缸盖中间甲板的 XCT 样品的三维表示。孔隙率为 0.176 %，孔隙包络体的最大直径为 $d_{e,max}$ 2.75 mm。单个缩孔的着色是随机完成的，仅用于更好地地区分单个缩孔 [5]。

期的微观组织的精细度，使用 $3\mu\text{m}$ 体素尺寸（快速凝固样品）和 $8\mu\text{m}$ 体素尺寸（缓慢凝固样品）的空间分辨率（体素尺寸 = 三维像素）。在分辨率分别为 $3\mu\text{m}$ 和 $8\mu\text{m}$ 时，所有相应样本的扫描样本体积平均约为 144 和 477mm^3 。

通过设置阈值，将每个体素定义为孔隙体积或致密金属。然后使用数字图像后处理来人为地增加所得孔隙体积的分辨率。相邻的孔隙体积被“合并”并作为一个更大的孔隙进行分析。聚集的标准是基于两个

$$\psi_{mean} = \frac{\sum_N (v_i \psi_i)}{\sum_N v_i} \quad \text{(Equation 2)}$$

In this equation, N represents the total number of all pores within a sample.

在该公式中，N 表示样品内所有缩孔的总数。

	Porosity, g_p (vol.-%)	Maximum envelope diameter, $d_{e,max}$ (μm)	Mean weighted sphericity, ψ_{mean}
Min	0.003	218	0.18
Max	0.392	3961	0.90

Table 1 summarizes the minimum and maximum characteristic porosity parameters determined by the previously presented methods.

Table 1: List of minimum and maximum characteristic porosity values of all 30 evaluated samples

表 1 总结了由先前提出的方法确定的最小和最大特征孔隙度参数。

表 1：所有 30 个评估样品的最小和最大特征孔隙率值列表

single pore, respectively.

To describe the characteristic pore morphology within a sample, a volume-weighted mean sphericity ψ_{mean} is determined, also referred to as mean sphericity in the following. This parameter weights large pores, due to their volume, significantly stronger than small pores. In the conducted evaluations, this approach was shown to be very reliable with regard to the use of different resolutions in CT scanning. Also, it minimizes the influence of very small pores that lie at the resolution limit of the computer tomograph. These very small pores are the most error-prone ones and are negligible for lifetime prediction.

5. Result of the Pore Analyses

As can be seen from Table 1, there are significant differences between the measured values. The porosity varies from very low values of 0.003 vol% to moderate values of 0.392 vol%. Due to the non-standardized evaluation routine of the CT measurements as well as the post-processing of the data, no measurement error can be specified. Therefore the main focus lay on determining the pore size as robustly as possible.

Compared to the small variations in total porosity, significant differences occur for both the maximum envelope diameter $d_{e,max}$ (about 0.2 to 4mm) and the characteristic pore morphology ψ_{mean} (0.18 to 0.90). This shows that the individual pores have significantly different shape characteristics within a narrow overall total range in

缩孔之间的距离及其等效球直径：如果较小的等效球直径达到或超过孔间距，则将孔合并。用于此目的的分析程序由奥地利莱奥本大学通用机械工程系开发。Garb 等人在别处讨论了 XCT 测量和分析的详细信息，以及 XCT 辐射源的适用性、所需的分辨率、所需的扫描体积大小和数据处理技术。^[4]

图 1 显示了一个带有相关包络体的缩孔。为了表征每个缩孔的大小，这些包络体的最大尺寸被定义为包络直径 d_e 。每个样本内的最大值在下文称为最大包络直径 $d_{e,max}$ 。

球形度的测量描述了体积与物体表面积之比偏离球体的程度。借助该量，可以表征孔的形态。此处，球形度必须在值 1 “完美球体” 和 0 “与球体的完美偏差” 之间。孔隙的球形度使用以下公式计算：

这里 s_i 和 v_i 分别是单个缩孔的表面积和体积。

为了描述样品内的特征缩孔形貌，确定了体积加权平均球形度 ψ_{mean} ，在下文中也称为平均球形度。由于大孔隙的体积，该参数对大孔隙的权重明显强于小孔隙。在进行的评估中，这种方法被证明在 CT 扫描中使用不同分辨率方面非常可靠。此外，它还最大限度地减少了位于计算机断层扫描仪分辨率极限的非

porosity. A more precise understanding of the correlation between these variables is thus essential for quantitative statements about the material's application behavior.

Figure 2 shows exemplarily a sample of the alloy AlSi8Cu3 from the tween deck in 3D. The sample contains only 0.176% porosity but has a maximum diameter of the pore envelopes of 2.75 mm. The pores are highly tortuous, i.e. twisted and branched. Thus, a small absolute pore volume already leads to significant pore dimensions. A small amount of porosity can lead to defect sizes that are relevant for cyclic fatigue prediction.

Figure 3 shows the relationship between the maximum envelope diameter and porosity for the two investigated alloys. The trend is assumed to be linear in the first approximation and the scatter around the assumed linear relationship increases significantly with increasing porosity.

The presumed linear relationship between maximum envelope diameter and porosity is noteworthy in that all samples from both alloys follow the same trend despite being apart by about 2.5 wt% in copper and about 1 wt% in silicon as well as being extracted from three different positions with varying solidification rates.

The higher maximum porosity level exhibited by the AlSi8Cu3 alloy samples can be explained primarily by the increased copper content. Copper is known to destabilize the eutectic solidification front in cast aluminum alloys, causing the last solidifying zone to solidify in a spongy manner^[6]. The resulting reduced permeability of the solidifying microstructure leads to earlier isolation of fluid regions, forming the potential for larger porosity volumes.

Figure 2: Three-dimensional representation of an XCT sample from the tween deck of an AlSi8Cu3 cylinder head. The porosity is 0.176%, the maximum diameter of the pore envelope is $d_{e,max}$ 2.75mm. The coloring of the individual pores is done randomly and serves only for better differentiation of the individual pores^[5].

A sufficiently high local thermal gradient can in turn shorten the feeding paths of the sponge-like zone, compensating for the negative effects of the increased copper content on porosity. Moreover, copper in combination with strontium as a eutectic refining agent increases the size of eutectic cells^[7]. This results in an enlargement of the liquid residual melt areas - and a higher porosity potential. Finally, an increased copper content increases the solidification interval, especially in the Terminal Freezing Range (TFR₈₅₋₉₅: temperature interval between the solid fraction of 85% and 95%). The Al2Cu phase formed at the end of solidification exhibits a high volume contraction (about 8.4 vol%) upon solidification. The first factor reduces the feeding capacity of the alloy, the second factor increases the local feeding demand.

Another difference between the two alloys is the significantly higher iron content of the AlSi8Cu3 alloy, which is described in the literature as increasing porosity^[8]. In both cases, however, the alloys contain sufficient

常小的孔隙的影响。这些非常小的孔隙是最容易出错的孔隙，对于寿命预测来说可以忽略不计。

5. 孔隙分析结果

从表 1 可以看出，测量值之间存在显著差异。孔隙率从 0.003vol% 的极低值到 0.392vol% 的中等值不等。由于 CT 测量的非标准化评估程序以及数据的后处理，不能指定测量误差。因此，主要关注点在于尽可能稳健地确定缩孔尺寸。

与总孔隙度的微小变化相比，最大包络直径 $d_{e,max}$ (约 0.2 至 4mm) 和特征缩孔孔隙形貌 ψ_{mean} (0.18 至 0.90) 均存在显著差异。这表明在狭窄的总孔隙度范围内，各个孔隙具有显著不同的形状特征。因此，更准确地理解这些变量之间的相关性对于关于材料应用行为的定量陈述至关重要。

图 2 示例显示了 3D 中间甲板中的合金 AlSi8Cu3 样品。样品仅包含 0.176% 的孔隙率，但孔隙包络的最大直径为 2.75 mm。缩孔高度曲折，即扭曲和分枝。因此，小的绝对孔体积已经导致明显孔尺寸变化。少量的孔隙率会导致与循环疲劳预测相关的缺陷尺寸。

图 3 显示了研究中两种合金的最大包络直径和孔隙率之间的关系。在第一次近似中假设趋势是线性的，并且围绕假设的线性关系的散射随着孔隙度的增加而显著增加。

最大包络直径和孔隙率之间假定的线性关系值得注意，因为两种合金的所有样品都遵循相同的趋势，尽管铜中的重量百分比约为 2.5%，硅中的重量百分比约为 1%，并且从三个不同的位置提取不同的凝固速度。

AlSi8Cu3 合金样品表现出的较高的最大孔隙率水平主要可以通过增加的铜含量来解释。众所周知，铜会破坏铸造铝合金中的共晶凝固前沿，导致最后凝固区以海绵状方式凝固^[6]。凝固微观组织的渗透性降低导致流体区域的更早孤立，形成更大孔隙体积的潜力。

足够高的局部热梯度反过来可以缩短海绵状区域的补缩路径，补偿铜含量增加对孔隙率的负面影响。此外，铜与作为共晶细化剂的锶结合会增加共晶晶胞的尺寸^[7]。这导致液体残余熔体区域的扩大 - 和更高的孔隙率潜力。最后，增加的铜含量会增加凝固区间，特别是在末段凝固区间 (TFR₈₅₋₉₅: 85% 和 95% 的固体分数之间的温度间隔)。在凝固结束时

amounts of manganese to form the α -Al15(Fe,Mn)3Si2 phase instead of β -Al5FeSi. In contrast to the β -phase, the α -phase has an equiaxed topology, which makes it less detrimental to local feeding at the microstructure level and hardly increases the potential for pore formation^[9].

Figure 4 plots the evolution of the mean sphericity ψ_{mean} against porosity. With increasing porosity, a continuous decrease of the mean sphericity can be observed. The presumed relationship was approximated with a fit function (see Figure 4). This function results in a theoretical sphericity limit of 0.08 for high porosities and of about 0.8 for a porosity value approaching zero. The samples of both investigated alloys follow the same trend.

Despite the differences presented between the two alloys, the same basic behavior exists concerning the relationship of pore size to porosity amount (see Fig. 3), it can be assumed that there is also no direct dependence for the pore shape on the chemical composition, the solidification rate, or the length of the mushy zone (see Fig. 4). Rather, the dendritic structure present at the end of solidification seems to dictate the available space for pore formation. At very low porosity contents, pores with high sphericity are observed. Round pores are the expected undisturbed shape to minimize the interfacial energy. The shape of small pores is largely determined by this factor, especially since their shape is only slightly affected by contact with the dendritic structure due to their small size. As more porosity is formed, the maximum pore envelope increases linearly (see Fig. 3). In relation to the pore volume, this leads to a disproportionate increase in the pore surface - compared to a sphere with the same volume. Figure 4 shows this in the form of decreasing mean sphericity with increasing porosity. This decrease in sphericity is due to increased growth restriction of the growing pores by the dendritic microstructure. The higher the existing amount of porosity, the more tortuous the largest pores become. Further analysis^[10] has shown that this behavior is not necessarily the case, but is

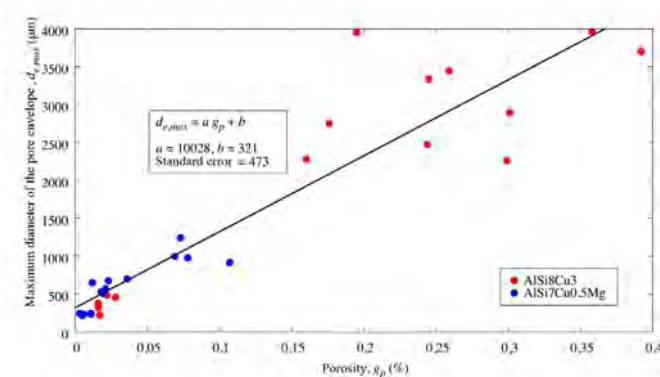


Figure 3: Plot of maximum envelope diameter plotted against porosity [5].

图 3：最大包络体直径 - 孔隙度的关系图 [5]

形成的 Al2Cu 相在凝固时表现出高体积收缩 (约 8.4 vol%)。第一个因素降低了合金的补缩能力，第二个因素增加了局部补缩需求。

两种合金之间的另一个区别是 AlSi8Cu3 合金的铁含量明显更高，文献中将其描述为增加孔隙率^[8]。然而，在这两种情况下，合金都含有足够量的锰以形成 α -Al15(Fe,Mn)3Si2 相而不是 β -Al5FeSi。与 β -相相比， α -相具有等轴拓扑结构，这使得它对微观组织水平的局部补缩的危害较小，并且几乎不会增加孔隙形成的可能性^[9]。

图 4 绘制了平均球形度 ψ_{mean} 对孔隙度的演变。随着孔隙率的增加，可以观察到平均球形度的持续降低。假定的关系用拟合函数近似 (见图 4)。该函数导致理论球形度极限为 0.08 (高孔隙率) 和约 0.8 (接近零的孔隙率值)。两种研究合金的样品都遵循相同的趋势。

尽管两种合金之间存在差异，但在缩孔尺寸与缩孔数量的关系方面存在相同的基本行为 (见图 3)，可以假设缩孔形也没有直接依赖于化学成分，凝固速率，或糊状区的长度 (见图 4)。相反，凝固结束时出现的枝晶结构似乎决定了缩孔形成的可用空间。在非常低的孔隙度含量下，观察到具有高球形度的缩孔。圆形孔是预期的不受干扰的形状，以最大限度地减少界面能量。小孔的形状很大程度上由这个因素决定，特别是由于它们的尺寸很小，因此它们的形状仅受与枝晶结构接触的轻微影响。随着更多孔隙度的形成，最大孔隙包络体线性增加 (见图 3)。就缩孔体积而言，这导致缩孔表面不成比例地增加 - 与具有相同体积的球体相比。图 4 以平均球形度随着孔隙度的增加

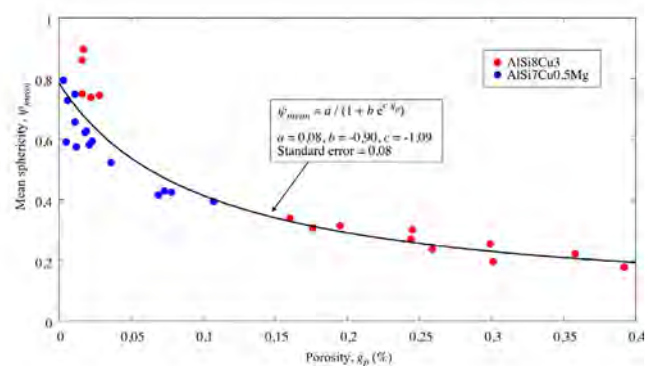


Figure 4: Plot of volume-weighted mean sphericity versus porosity

图 4：加权体积平均球形度与孔隙度的关系图

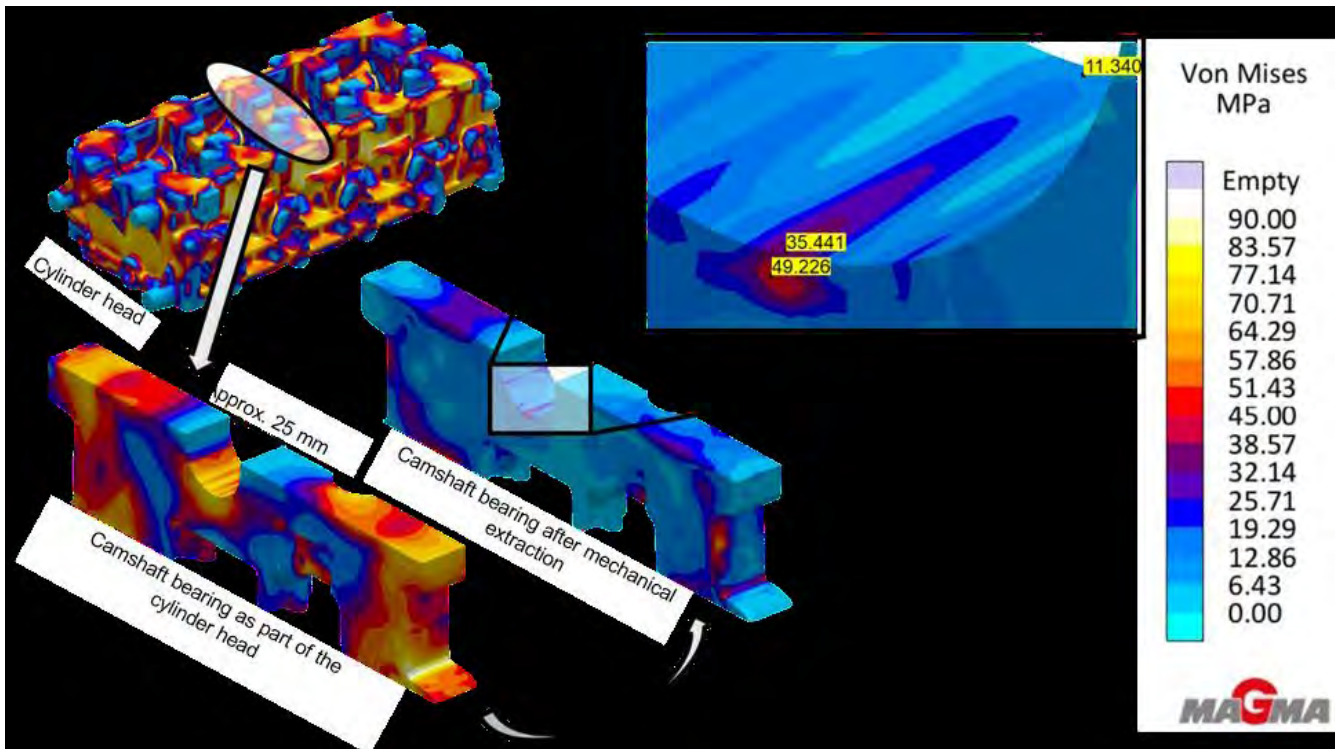


Figure 5: Representation of the simulated Von Mises equivalent stress after T6W heat-treatment of the entire cylinder head (top left), in the camshaft bearing as part of the cylinder head (bottom left) and after mechanical extraction of the camshaft bearing for the validation tests (center)

图 5：T6W 热处理后的整个缸盖（左上）、作为缸盖一部分的凸轮轴轴承（左下）和凸轮轴轴承机械提取后（中间）的模拟 Von Mises 等效应力

probably limited to melt of low gas content (in the case of aluminum casting alloys low hydrogen). In the case of the specimens presented in this work, pore formation can be assumed to occur very late in the solidification process. The dendritic microstructure thus has a strong impact on the development of the pore shape.

6. Residual Stress Distribution after Heat Treatment

The casting process and heat treatment of aluminum castings can lead to significant residual stresses. Since these residual stresses can have both beneficial and detrimental effects on the loads that can be borne when the component is used, they must be taken into account already during the component design. If disadvantageous stress conditions cannot be avoided due to the part design, sensible adjustments (geometry, quenching process after solution annealing) can already be made at this stage. For the AlSi7Cu0.5Mg cylinder head, the residual stresses were calculated based on its T6W heat treatment (water quenched) using MAGMASOFT® [A]. MAGMASOFT® can also be used to account for the stress redistributions resulting from cutting a sample from the cylinder head. The result is shown in Figure 5.

After heat treatment, significant residual stresses are

而降低的形式显示了这一点。这种球形度的降低是由于枝晶状微观组织对正在长达的缩孔的生长限制增加所致。存在的缩孔数量越高，最大的缩孔变得越褶皱。进一步的分析^[10]表明，这种行为不一定是这种情况，但可能仅限于低气体含量的熔体（在铝合金铸造合金低氢的情况下）。在这项工作中介绍的样本的情况下，可以假设孔隙形成发生在凝固过程的后期。因此，枝晶状微观组织对缩孔形状的发展具有强烈的影响。

6. 热处理后的残余应力分布

铝合金铸件的铸造工艺和热处理会产生明显的残余应力。因为这些残余应力对部件服役期间承受的载荷有利有弊，因在部件设计过程中就要考虑这些残余应力。如果由于零件设计无法避免不利的应力条件，则可以在此阶段进行合理的调整（几何形状、固溶退火后的淬火工艺）。对于 AlSi7Cu0.5Mg 气缸盖，残余应力是基于使用 MAGMASOFT® [A] 的 T6W 热处理（水淬）计算的。MAGMASOFT® 也可用于计算从缸盖上切割样品导致的应力重新分布。结果如图 5 所示。

present in the casting. With a Von Mises equivalent stress of more than 90 MPa in case of the T6W treatment, these must be taken into account in a fatigue simulation. The main cause of the high stresses is the different cooling rates during water quenching after solution heat treatment (T6W). The mechanical removal of the camshaft bearing samples for the validation tests from the heat-treated cylinder heads results in the redistribution of the residual stresses. This process involves cutting the specimen region clear from the overall cylinder head and then calculating a new mechanical equilibrium in the specimen. The result is a changed stress state with asymmetrical stress distribution in the notch area. The Von Mises stress reaches values of up to approx. 50 MPa, see Fig. 5.

7. Estimation of Local Fatigue Strength Using the Example of the Camshaft Bearing

It is common practice to predict the local dendrite arm spacing (DAS) from the local solidification time. This in turn can be simply correlated with the tensile strength. In die casting the DAS, via the local cooling rate, is strongly controlled by the respective distance to the mold wall. As the distance from the mold surface increases, the DAS in the camshaft bearing increases. Simple correlations can therefore be used to predict the local tensile strength (Rm) using tensile tests for known values of the DAS. The tensile strength can be used for improved estimation of cyclic properties through established approaches. It becomes clear that this approach only takes into account the local solidification rate. Local changes in thermal gradient, alloy-specific solidification morphology, or microporosity do not affect the predicted fatigue properties. Thus, while

热处理后，铸件中存在大量的残余应力。在 T6W 处理的情况下，Von Mises 等效应力超过 90MPa，在疲劳模拟中必须考虑这些残余应力。高应力的主要原因是固溶热处理 (T6W) 后水淬过程中不同的冷却速度。凸轮轴轴承样品从经过热处理的缸盖上机械去除会导致残余应力的重新分布。该过程包括从整个缸盖上切下试样，然后计算试样中的新机械平衡。缺口区域中具有不对称应力分布。Von Mises 应力值高达约 50MPa，见图 5。

7. 以凸轮轴轴承为例估算局部疲劳强度

局部枝晶间距 (DAS) 通常是根据凝固时间预测的，然后简单的跟拉伸强度对应起来。在压铸过程中，DAS (通过局部冷却速率) 受到与模具壁的相应距离的控制。随着与模具表面距离的增加，凸轮轴轴承中的 DAS 增加。因此，使用已知 DAS 值的拉伸试验，可以使用简单的相关性来预测局部拉伸强度 (Rm)。通过已建立的方法，拉伸强度可用于改善对循环特性的估计。很明显，这种方法只考虑了局部凝固速率。热梯度、合金特定凝固形貌或微观缩孔的局部变化不会影响预测的疲劳性能。因此，虽然与恒定的材料特性相比，这种方法可以改进组件设计，但它并没有考虑到局部效应。预期和观察到的失效行为之间的显著偏差仍然存在。

通过考虑局部微观缩孔，从而根据孔包络的最大直径考虑局部存在的缺陷尺寸，可以显著扩展上述方

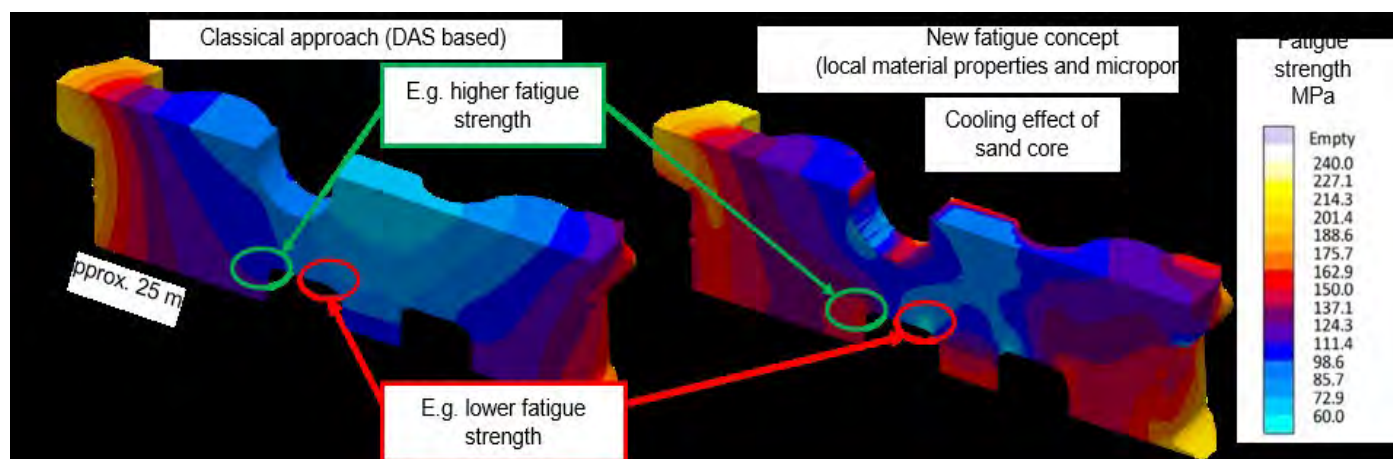


Figure 6: Plot of the tension-compressive fatigue strength in section through the center of the camshaft bearing using the "classical" approach, based on the local DAS (left), as well as based on the additionally included microporosity prediction and the derived defect size (right)

图 6：基于局部 DAS 使用“经典”方法绘制的拉伸 - 压缩疲劳强度图 (左)，以及考虑包括微孔预测和衍生缺陷而绘制的拉伸 - 压缩疲劳强度图 (右)

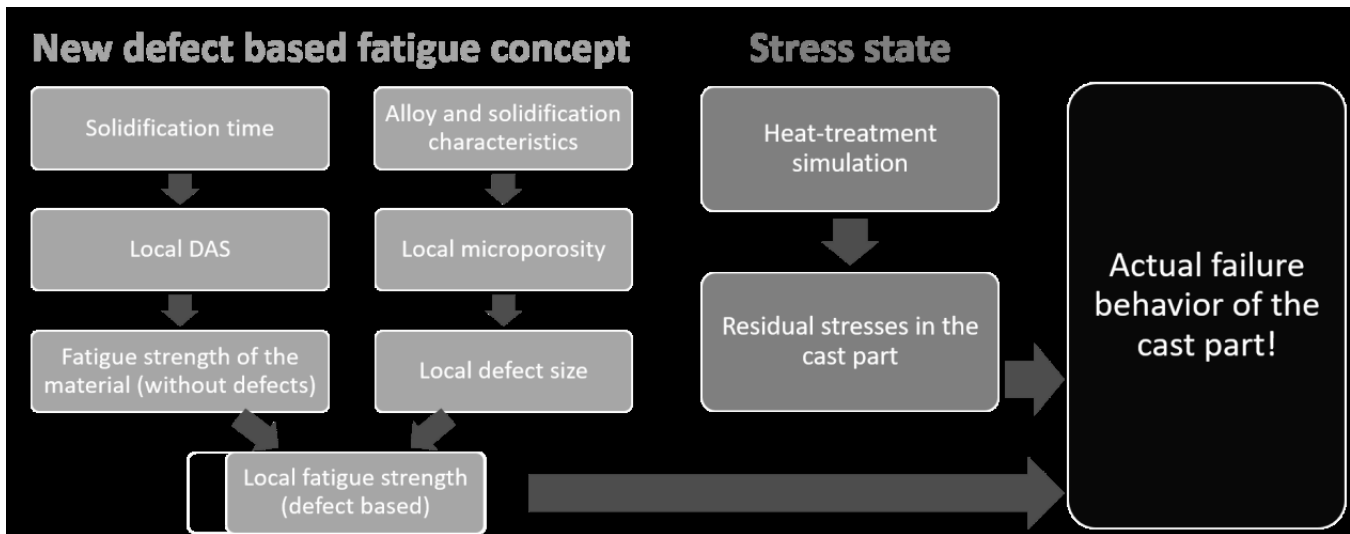


Figure 7: Presentation of the newly developed concept for predicting the actual failure behavior of aluminum castings

图 7：用于预测铝铸件实际失效行为的新开发概念的介绍

this approach leads to improved component design compared to constant material properties, it does not account for local effects. Significant deviations between the expected and the observed failure behavior do remain.

By considering the local microporosity and thus the locally present defect size in terms of the maximum diameter of the pore envelopes, the above approach can be significantly extended. For the prediction of local microporosity, several different models are described in the literature. In this work, reference is made to the publication by Carlson et al. [11], which was used to predict the local amount of microporosity for the camshaft region of the cylinder head. Even though a very low porosity level prevails in most areas, significantly higher local microporosity levels are also evident, some of which exceed the investigated test space. Therefore, the predicted porosity level was limited to 0.5% by volume.

The defect size and microstructure characteristics allow the prediction of the local cyclic fatigue properties [12]. Figure 6 shows a comparison of the fatigue strength in tension-compression loading calculated by MAGMASOFT® in the center of the camshaft bearing. The classical approach considering only the DAS (left) shows the effect of the decreasing cooling rate from the die to the thermal center in the middle of the casting. Only by including the microporosity (right) are local effects taken into account, such as the reduction of microporosity near the sand core as well as the effect of a large thermal gradient.

To prove the suitability of the explained concept, the Institute for General Mechanical Engineering in

法。对于局部微观缩孔的预测，文献中描述了几种不同的模型。在这项工作中，参考了 Carlson 等人的论文，用于预测缸盖凸轮轴区域的局部微观缩孔的数量。尽管在大多数区域普遍存在非常低的孔隙度水平，但局部微孔隙度水平也明显较高，其中一些超过了所研究的测试空间。因此，预测的孔隙度水平限制在 0.5%（按体积计）。

缺陷尺寸和微观组织特征允许预测局部循环疲劳特性 [12]。图 6 显示了在凸轮轴轴承中心由 MAGMASOFT® 计算的拉伸 - 压缩载荷下的疲劳强度的对比。仅考虑 DAS（左）的经典方法显示了从模具到铸件的热中心的冷却速率降低的影响。只有包括微观缩孔（右）才能考虑局部效应，例如砂芯附近微观缩孔的减少以及大热梯度的影响。

为了证明所解释概念的适用性，位于奥地利莱奥本的通用机械工程研究所对凸轮轴轴承进行了验证测试。同样，AVL List 公司使用 FEMFAT 软件模拟了失效行为。FEMFAT 中使用的所有局部机械性能以及残余应力均使用 MAGMALink 模块进行传输。图 7 再次总结了新开发的预测铝铸件实际失效行为的方法：只有通过考虑包括局部存在的微观缩孔以及铸造和热处理过程中的残余应力，才能真实地预测部件行为。

图 8 显示了凸轮轴轴承样品的验证测试结果。在测试条件下将性能（拉伸 - 压缩疲劳强度和残余应力状态）转移到 FE 网格。如果不考虑局部材料性能和

Leoben, Austria, conducted validation tests for the camshaft bearing. Similarly, AVL List GmbH simulated the failure behavior using the FEMFAT software. All local mechanical properties used in FEMFAT, as well as the existing residual stresses, were transferred using the MAGMALink module. Figure 7 summarizes again the newly developed approach for predicting the actual failure behavior of an aluminum casting: The component behavior is predicted realistically only by including the locally present microporosity as well as the residual stresses from the casting and heat-treatment process.

Figure 8 shows the results of the validation tests with the camshaft bearing samples. The properties (tension-compression fatigue strength and residual stress state) were transferred to the FE mesh in the test condition. Without taking local material properties and residual stresses into account, a realistic prediction of the failure behavior is not possible.

If only residual stresses combined with homogeneous material properties are taken into account, the vibration resistance is overestimated (Fig. 8 yellow data series). The same is true if the DAS without residual stresses is considered (Fig. 8 green data series). Compared to the first case (yellow data series) the deviation between the real tests and the simulation is smaller. Only by considering both factors, i.e. the local residual stress state and the local property distribution, the observed cyclic component behavior can be satisfactorily predicted (Fig. 8 red data series).

8. Summary and Conclusion

In the course of a comprehensive analysis of microporosity in cylinder heads for two typical casting alloys, a correlation between the characteristic pore size, pore shape, and the overall porosity of the samples was determined. In this process, the sphericity of the pores decreases continuously, whereas the maximum pore dimensions increase with increasing porosity. Both dependencies are directly related to the mechanisms of pore formation in a dendritic microstructure, which determines both the pore shape and the pore size. The determined relationship was used to predict a porosity-based fatigue strength. In addition to the cooling rate, this allows both the local feeding properties and the specific solidification characteristics of the alloy to be taken into account; thus significantly improving the local prediction of the cyclic fatigue strength of the component. Furthermore, the residual stress state after T6W heat-treatment was considered. With the help of validation tests, it could be demonstrated that the local fatigue strength, as well as the residual stress state, are necessary to achieve a satisfactory accuracy in the prediction of the failure behavior. The developed methodology thus represents a significant extension of previously used methods for the design of highly loaded cast components. The targeted use of this approach in the context of virtual designs of experiments (DoE)

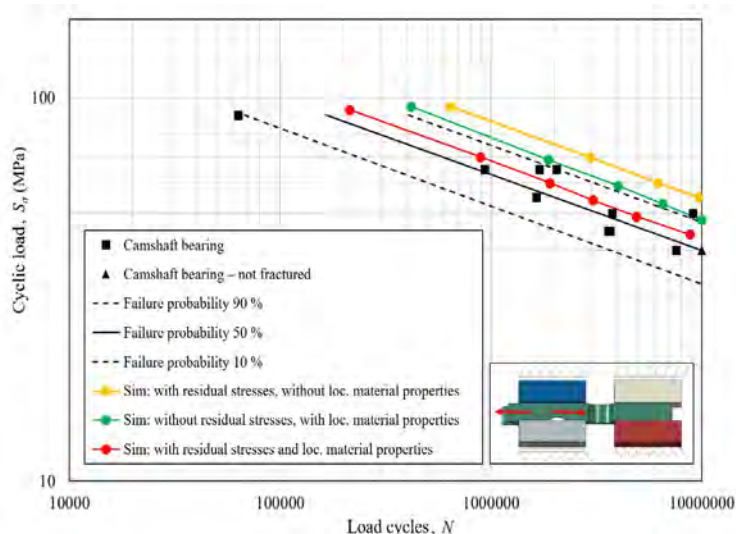


Figure 8: Result of the tension-compressive fatigue test of the cylinder head camshaft bearing samples ($R = -1$) of the alloy $AlSi7Cu0.5Mg$ (T6W) [13]

图 8: 合金 $AlSi7Cu0.5Mg$ (T6W) 的缸盖凸轮轴轴承样品 ($R = -1$) 的拉压疲劳试验结果 [13]

残余应力，就不可能对失效行为进行真实的预测。

如果仅考虑残余应力和均质材料特性，则抗振性被高估（图 8 黄色数据系列）。如果考虑没有残余应力的 DAS，情况也是如此（图 8 绿色数据系列）。与第一种情况（黄色数据系列）相比，真实测试与模拟之间的偏差更小。只有考虑局部残余应力状态和局部性能分布这两个因素，才能令人满意地预测观察到的循环分量行为（图 8 红色数据系列）。

8. 总结与结论

在对两种典型铸造合金的气缸盖微观缩孔进行综合分析的过程中，确定了样品中的特征缩孔尺寸、缩孔形状和总孔隙率之间的相关性。在这个过程中，孔隙的球形度不断减小，而最大孔隙尺寸随着孔隙率的增加而增加。这两种依赖性都与树枝状微结构中的孔形成机制直接相关，这决定了孔的形状和孔径。以上可用于预测基于孔隙率的疲劳强度。除了冷却速度之外，这还允许考虑合金的局部进给特性和特定的凝固特性；从而显著提高了部件循环疲劳强度的局部预测。此外，考虑了 T6W 热处理后的残余应力状态。在验证测试的帮助下，可以证明局部疲劳强度以及残余应力状态对于在预测失效行为方面达到令人满意的准确性是必要的。因此，所开发

promises a precise development of components as well as their robust production in the real casting process.

9. Acknowledgments

The authors would like to thank Nemak Linz for providing the castings and AVL List GmbH for the simulations of the validation samples. Thanks also go to Materials Center Leoben GmbH for performing the CT scans and to the Chair of General Mechanical Engineering at the University of Leoben, which developed the failure model and performed the validation tests. Work carried out by the Chair was financially supported by Austrian governmental institutions within the framework of the COMET funding program ("Integration of casting simulation into the operationally stable component design of cast aluminum components", COMET K2, Project A1.20). ■

的方法是以前用于设计高负载铸造部件的方法的重要扩展。在虚拟实验设计 (DoE) 的背景下有针对性地使用这种方法保证了组件的精确开发以及它们在实际铸造过程中的稳健生产。

9. 致谢

感谢 Nemak Linz 提供铸件，感谢 AVL List 公司提供验证样品的模拟。还要感谢 Leoben 公司材料中心进行 CT 扫描，感谢 Leoben 大学通用机械工程系主任，他开发了失效模型并进行了验证测试。主持开展的工作得到了奥地利政府机构在 COMET 资助计划（“将铸造模拟集成到铸铝部件的运行稳定部件设计中”，COMET K2，项目 A1.20）框架内的财政支持。■

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The surface finish of our castings is very smooth with almoWe have a Demo Unit at our headquarters, in Peterborough, so don't take our word for it, come and try it! Contact sales@ofml.net/spares@ofml.net to book your trial or to ask for further information about the Omega Foundry Vac. ■

Omega Foundry Vac 是加入 Omega 设备组合的最新产品。这是完美的铸造厂辅助设备，带有适用于大多数砂、丸、粉末、粒状产品和金属废料的抽吸输送装置。通过 10 米长的软管，Vac 每小时可处理多达 10 吨的干砂，材料体积密度约为 1600kg/m³，有效距离可达 30m。

产品特点:

- 使用叉车轻松搬运，Foundry Vac 重量不到 2000kg;
- 针对铸造环境的稳健设计;
- 750L 容量可拆卸料斗，用于物料收集;
- 操作简单，自清洁循环;
- 适合应用的软管尺寸和配件范围（易于互换）。我们在彼得伯勒的总部有一台演示设备，所以不要只听我们所说的，快来试验吧！请联系 sales@ofml.net 或 spares@ofml.net 预订您的试用版或获得更多信息。 ■

Calderys Removes the Stress of Bentonite Stock Management with Calde® E-Supply

凯得力公司 Calde® 电子供应系统消除膨润土库存管理的压力

CALDE® e-Supply takes over the monitoring and ordering of bulk materials, ensuring foundries never run out of critical supplies, while freeing up operators to focus on more important tasks.

Ensuring consistent supply of bentonite is a crucial element of foundry management. Simply put: you don't want to run short.

However, keeping track of bentonite consumption and supply can be complex. This is particularly so at larger foundries, which might receive multiple deliveries a week to keep up with demand, at foundries with limited bentonite storage capacity, or at foundries serving the automotive sector, where even the slightest delay is unacceptable.

Automating the bentonite management

Supporting foundries at potential pain points and helping to improve the ease of doing business is one of the main aims of the digital innovation strategy at Calderys. The company has spent significant time understanding what these pain points are and developing a product development pathway that aligns with them. It's a customer-centric approach that enables the company to offer solutions that make a tangible difference to foundries' day-to-day operations.

One of the solutions that has resulted from this approach is the CALDE® e-Supply stock management system. Volumetric sensors installed inside the silo keep track of stock levels. These data are sent to the e-Supply software platform, which combines them with other factors, such as silo capacity, historic usage rates and the distance from a Calderys supply center, to determine when a new shipment of material will be needed. At this point, the system will create and send Calderys an automated order.

Maximilian Eilhard, Account Manager Metallurgy at Calderys, explains: "CALDE® e-Supply is an example of a vendor-managed inventory (VMI) system. These have long been used in the foundry industry to manage stocks of various process gases, such as hydrogen and oxygen.

"We have simply taken this well-known concept and applied it to manage bulk material supplies, such as bentonite and bentonite premixes, to prevent stock shortfalls and emergency orders." Foundries are therefore assured of proper and demand-based material planning, continued Eilhard.

Calde® 电子供应系统可以执行散装材料的监控和订购，确保铸造厂永远不会出现关键供应断供现象，同时能够让作业人员专注于更重要的工作。

确保膨润土的持续供应是铸造厂管理的关键要素。简单地说，不能出现短缺。

然而，跟踪膨润土的消耗和供应非常复杂，在较大的铸造厂更是如此。这样的情况，在膨润土储存能力有限的铸造厂，或者在服务于汽车行业的铸造厂，即使是最轻微的延迟都是不可接受的。

膨润土供应自动化管理

支持铸造厂解决潜在的痛点和助力提高业务的便利性是加州大学数字创新战略的主要目标之一。该公司花费大量时间了解这些痛点，并开发了与之一致的产品开发途径。这是一种以客户为中心的方法，使公司能够提供解决方案，对铸造厂的日常运营产生切实的影响。

这种方法产生的解决方案之一是 Calde® 电子供应库存管理系统。安装在筒仓内的体积传感器可以跟踪库存水平。这些数据被发送到电子供应软件平台，该平台将其与其他因素相结合，如筒仓容量、历史使用率和距凯得力公司供应中心的距离，以确定何时需要新的材料。此时，系统将创建并自动发送订单。

凯得力公司冶金客户经理马克西·艾哈德解释说：“Calde® 电子供应是供应商管理的库存 (VMI) 系统的一个例子。这些系统长期以来在铸造行业被用于管理各种工艺气体的库存，如氢气和氧气。

“我们只是采用了这个众所周知的概念，并将其应用于管理散装材料的供应，如膨润土和膨润土预混料，以防止库存短缺和紧急订单。”因此，铸造厂保证适当的和基于需求的材料计划，艾哈德说。

“有了 Calde® 电子供应系统，再也不会出现紧急的订单。它还消除了向凯得力公司发送订单时出现的人为错误，因为系统直接连接到我们的 ERP 系统并

“With CALDE® e-Supply, there are no more rush orders. It also eliminates the potential for human error creeping in when sending orders to Calderys, as the system is connected directly into our ERP system and runs automatically.”

CALDE®e-Supply: a simple implementation process

Installation at the customer site is relatively straightforward. In the first step, a technical audit is undertaken to establish whether there are any existing silo monitoring sensors on site and, if so, whether the output from those systems can be integrated with e-Supply. If no sensors are present or if they are unable to be integrated with e-Supply, new sensors are installed in the silos.

The sensors are then connected to an outstation box, installed close to the silo, which takes the sensor outputs and sends them to e-Supply's web-based interface. Here, they can be viewed by foundry personnel at any time, from anywhere, via mobile devices, as well as on traditional desktop systems.

“We generally start running CALDE® e-Supply in parallel with the foundry's traditional bentonite management system, with the customer continuing to place orders,” said Eilhard. “When we have established that the system works and is running well – building up the trust of the foundry operators – we let CALDE®e-Supply take over the ordering.”

Technology at the service of productivity

Pilot trials of CALDE® at Olsberg GmbH and Miele & Cie. KG have proven successful, with the technology now rolled out at further foundries.

Implementation at Olsberg GmbH was a particular test for the CALDE® e-Supply system. Located in North Rhein-Westphalia, Germany, the company produces series and hand-formed, core-intensive iron castings. The key challenge, however, was the site's low silo capacities for bentonite and a bentonite-coal dust premix: just 37 tonnes and 31 tonnes, respectively.

“There's not much capacity at Olsberg GmbH to add new shipments, which come in 25-tonne loads,” explained Eilhard. “The foundry has to run the silo level down quite low before it can take new shipments. To determine at what point an automatic product order should be generated, CALDE® e-Supply must ensure the silos have capacity to take delivery of the load, but sufficient remaining stock in the meantime to make sure the foundry doesn't run short.”

Despite the challenge, CALDE®e-Supply has been successfully implemented at Olsberg GmbH, providing peace of mind at a previous pain point. And as the foundry's general manager pointed out, “if the CALDE® e-Supply systems work at our plant, it will work anywhere”.

“The ultimate benefit of e-Supply is time,” concluded Eilhard. “Customers no longer need to spend time managing and worrying about stocks of bentonite and other bulk materials, so they can focus elsewhere, on more critical tasks.” ■

自动运行。”

Calde® 电子供应系统：简单的实现进程

在客户现场的安装相对简单。第一步，先进行技术审计，以确定现场是否存在任何现有的筒仓监测传感器，如果有，这些系统的输出是否可以与电子供应集成。如果没有传感器或无法与电子电源集成，则会在筒仓中安装新的传感器。

然后，传感器被连接到仪表外站箱，安装在筒仓附近，它接收传感器的输出，并将其发送到电子供应的网络界面。在这里，铸造厂的工作人员可以在任何时间、从任何地方、通过移动设备以及在传统的桌面系统上查看它们。

艾哈德说：“我们通常在与铸造厂传统的膨润土管理系统的同时运行 Calde® 电子供应系统，客户继续下订单。当我们确定系统工作和运行良好——建立铸造运营商的信任——我们让 Calde® 电子供应系统接管订购。”

技术服务于生产力

Calde® 电子供应系统在奥尔斯堡公司和 Miele & Cie. KG 公司的试点试验已经证明是成功的，目前该技术已进一步在铸造厂推广。

在奥尔斯堡公司的实施是对 Calde® 电子供应系统的特殊测试。该公司位于德国北莱茵 - 威斯特法伦州，手工造型方式生产系列多芯的铸铁件。然而，关键的挑战是该公司的膨润土和膨润土 - 煤粉预混料的筒仓容量低：分别只有 37t 和 31t。

“奥尔斯堡公司的筒仓没有足够的空间接受新的散装料，每次运输的散装料为 25t。”艾哈德解释说，“铸造厂只有在筒仓仓位很低时，才能接收新的材料。为了确定在什么时候应该自动发送产品订单，Calde® 电子供应系统必须确保筒仓有空间接收新材料，但在此期间须有足够的剩余库存，以确保铸造厂不会短缺。”

尽管面临挑战，Calde® 电子供应已经在奥尔斯堡公司成功实施，解决了之前的痛点问题。正如铸造厂总经理指出的，“如果 Calde® 电子供应系统在能够在我们的工厂运行，它将能够任何工厂工作。”

“电子供应的最大好处是及时，”艾哈德总结道，“客户不再需要花时间管理和担心膨润土和其他散装材料的库存，所以它们可以集中精力在其他地方，完成更关键的任务。” ■

10 Million Moulds in under 5 Years: Disamatic C3-350 Delivers Incredible Uptime with High Quality and Low Maintenance

5年内超1000万型：高质量和低维护成本的DISAMATIC C3-350的超预期正常运行时间

Since Chinese foundry Guangzhou Deshan CNC Technology Co. Ltd. installed its first DISAMATIC C3-350 machine in December 2017, this green sand, vertical moulding line has produced more than 10 million moulds. The moulding machine runs 24/7 and produces an average of over 7,000 moulds every day.

With a 1.2% scrap rate, the DISA machine adds outstanding quality and high uptime to its blazing speed. The line is incredibly low maintenance, freeing up over 2 hours extra production time per day compared to the foundry's previous moulding machine supplied by a DISA competitor.

Impressed by its performance and reliability, Guangzhou Deshan is about to buy another DISAMATIC C3 to expand its annual production capacity to 30,000 tons and beyond.

"DISAMATICs are famous for combining speed with consistent high quality and uptime," says Leon Gu, VP After Sales at DISA Asia Pacific. "The DISAMATIC C3 is purpose-built to offer lower-volume foundries a big speed and quality boost. It produces small series or lower volumes economically and, on top of that, is an affordable, China-built machine

自从中国广州德善数控科技有限公司（以下简称广州德善）于2017年12月安装了第一条DISAMATIC C3-350造型线起，这条黏土砂垂直造型线至今已生产了1000多万个铸型。造型线24小时运行，平均每天生产超过7,000铸型。

与迪砂设备相关的废品率仅为1.2%，极快的造型速度匹配卓越的铸件品质和更长的正常运行时间。该生产线的维护成本极低，这与之前使用的其他品牌造型机相比，每天可多出至少2小时的额外稳定生产时间。

基于迪砂造型线的卓越性能和高可靠性给人留下了深刻的印象，广州德善计划购买另一条DISAMATIC C3造型线，将其年产能扩大到30,000t或更大。

"DISAMATIC垂直造型线以造型速度与始终如一的高质量 and 正常运行时间相结合而闻名，"迪砂亚太区售后副总裁顾琳俊说到。"DISAMATIC C3是专为中小铸造





厂提升铸件质量同时提高生产效率而研发的产品。这个来自中国制造的设备提供更经济、更灵活的生产方式，同时降低每一个铸件的生产成本，迪砂可以通过出色的本地服务和备件支持快速向中国市场供应。”

低维护需求，原装零件提供 2 小时的额外生产时间

广州德善成立于 2001 年，总部位于广东省广州市南沙区。在安装

that DISA can supply quickly to the Chinese market with outstanding local service and spares support.”

Low maintenance, genuine parts give 2 hours extra production

Guangzhou Deshan was founded in 2001 and is based in Nansha Guangzhou city, Guangdong province. Before installing the DISAMATIC C3-350, the foundry ran a slower moulding line from a Chinese competitor which had to be maintained and repaired for 2.5 hours every day, losing valuable production time. In contrast, the DISAMATIC C3-350 only needs around 20 minutes daily maintenance.

“The DISAMATIC C3 is very durable and is also very simple to maintain,” says Michael Yin, Service Manager at DISA Asia Pacific. “Guangzhou Deshan has also chosen to only fit original DISA spare parts. Because these OEM parts fit perfectly and have longer lifetimes, that means less planned and unplanned downtime. In the end, that gives the foundry the lowest running costs.”

Speed plus quality, made in China

Available in three speeds (up to 350 uncored moulds per hour) and in a range of sizes, the DISAMATIC C3 can produce a wide variety of grey iron, ductile iron and other metal castings. The two faster models can be fitted with an optional automatic coresetter. The DISAMATIC C3 offers maximum performance for minimum investment, and a high ROI over a long service life.

“The DISAMATIC C3 uses advanced vertical moulding technology that easily outperforms its competitors but it is also flexible and cost-effective,” says Mr Gu. “It’s the clever choice for foundries that want to grow quickly.”

For more information on the DISAMATIC C3, please visit: <https://www.disagroup.com/en-gb/foundry-products/moulding-solutions/disamatic/disamatic-c-lines>. ■

DISAMATIC C3-350 之前，该铸造厂运行的是一条来自其他品牌的造型线，该生产线每天至少花费 2.5 小时在保养维护上，从而浪费了宝贵的生产时间。相比之下，DISAMATIC C3-350 每天仅需约 20 分钟的维护时间。

“DISAMATIC C3 非常耐用，维护起来也非常简单，”迪砂亚太区服务经理尹国明说到。“广州德善坚持选择使用迪砂的原厂备件。由于这些原厂备件可与设备完美匹配且使用寿命更长，这意味着可以同时减少计划和计划外的停机时间。最终，这使得德善得运行成本持续降低。”

速度加品质，中国制造

DISAMATIC C3 系列有三种造型速度（每小时多达 350 个不下芯铸型）和各种型板尺寸可选，可生产各种灰铁、球墨铸铁和其他金属铸件。两款速度更快的型号可选配自动下芯机。DISAMATIC C3 以最少投资提供最高性能，并在较长的使用寿命内提供高投资回报率。

顾先生说：“DISAMATIC C3 采用最为先进的垂直造型技术，使您轻松超越竞争对手，灵活经济、提升效益。“对于希望快速发展的铸造厂来说，这是一个明智的选择。

更多关于 DISAMATIC C3 的信息，请访问网站：<https://www.disagroup.com/en-gb/foundry-products/moulding-solutions/disamatic/disamatic-c-lines> ■



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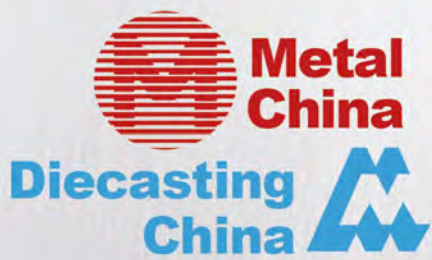
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赵 刚 (18911227996) zhaogang@foundry.com.cn

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联系人 Contact:

王 闯 Wang Chuang (18911227990)

陈海阔 Chen Haikuo (13381183827)

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