ANNUAL REPORT 2024



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FOREWORD

The Center for Research in Metallurgy (CRM Group) is an independent, not-for-profit organization dedicated to delivering cutting-edge technological R&D in metal and steel production processes, product development, and a broad array of metal applications. CRM Group applies a holistic product-process-application approach, with a strong emphasis on the industrial deployment of its innovations. CRM Group's research aligns with major societal priorities like the circular economy, energy transition, and digital transformation.

Our organization is supported by a robust network of over 45 industrial members, including global steel leaders like ArcelorMittal and Tata Steel, alongside raw material suppliers, non-ferrous metal producers, OEMs, and companies from sectors as diverse as chemicals, aeronautics and space, defense, energy, and recycling. In 2024, in addition to serving its members, CRM Group provided specialized services to more than 300 external clients. At CRM Group, health and safety remain our foremost priority. Although 2024 saw a rise in safety-related incidents, the implementation of a strengthened global safety action plan successfully reversed this trend. This included extensive shop floor audits and over 100 preventive safety visits. To foster a strong safety culture, monthly Toolbox Meetings were introduced to share best practices across the organization.

CRM Group is fully committed to contributing to the United Nations Sustainable Development Goals (SDGs). These goals have been embedded in both our strategic planning and research programs. We systematically assess - and when feasible, quantify - the impact of our work on various SDGs. For the second consecutive year, CRM Group's sustainability efforts were recognized with a certification award from the Walloon Chamber of Commerce. Additionally, we are actively deploying an ambitious renewable energy investment plan and progressing steadily in reducing our carbon footprint.

To execute its core mission, CRM Group is structured into six specialized research units, supported by a worldclass materials characterization laboratory. A major investment plan - exceeding €5 million - is underway to build new pilot lines, semi-industrial prototypes, and laboratory equipment. These investments reinforce CRM Group's leading position in R&D industrialization through its renowned upscaling approach.

In 2024, the economic climate began stabilizing, with inflation and energy prices reaching a more sustainable "new normal." However, the lingering effects of the preceding two years of high inflation impacted CRM Group's competitiveness compared to peer institutes in neighboring countries. To address this, CRM Group successfully launched a cost optimization initiative focused on procurement strategies and operational efficiency.

Our R&D projects for both effective and associate members achieved all main targeted deliverables, resulting in excellent customer satisfaction. These projects are organized under five strategic technological platforms:

- 1. Energy Transition
- 2. Circular Economy
- 3. Advanced Manufacturing
- 4. Digitalization
- 5. Sustainable Industrial Solutions and Applications

Throughout the year, CRM Group attained numerous significant milestones and was honored with several prestigious awards. In addition, a series of high-profile inaugural events were held, bringing together government ministers and leaders from the industrial sector - further underscoring CRM Group's central role in fostering innovation and collaboration within the metallurgy ecosystem.

This annual report presents the key highlights and achievements of 2024.

Thinus Van Den Berg President CRM Group Joeri Neutjens General Manager CRM Group

CRM GROUP'S COMMITMENT TO SUSTAINABLE DEVELOPMENT

CRM Group maintains a strong commitment to sustainable development, consistently seeking to minimize its environmental footprint and contribute to a more sustainable future. This dedication is not merely a statement but is demonstrated through concrete actions and ongoing initiatives across all facets of our operations.

We are proud to have successfully completed our first year of certification with the Liège Verviers Chamber of Commerce and Industry (CCI Liège Verviers), a testament to our commitment to implement sustainable practices. Building upon this achievement, we have already undertaken ten significant actions as part of our second year of certification, further solidifying our dedication to this crucial area.

A cornerstone of our sustainability efforts has been the completion of a **Double Materiality Assessment**. This rigorous analysis has allowed us to **identify the most relevant Environmental**, **Social**, **and Governance (ESG)** issues for both our stakeholders and our business. These identified ESG challenges will be fully integrated into our upcoming strategic plan, ensuring that sustainability is a core driver of our future direction and decision-making processes. This integration will ensure that our business strategy is aligned with the needs of our stakeholders and the broader societal imperative of sustainable development. Our key sustainability initiatives include:

- Environmental Analysis of Research Projects: Development of specific methodologies to integrate environmental considerations into our core research and development activities. These methodologies range from auto-analysis of our R&D deliverables according to a scoring grid, up to complete life cycle analyses.
- Employee Environmental Training: Implementation of a comprehensive training program to raise awareness and equip our team with the necessary knowledge and tools to contribute to our sustainability goals, as well as a yearly event dedicated to sustainable development.
- Consolidated Carbon Footprint Assessment: A comprehensive assessment encompassing scope 1, 2, and 3 emissions to understand our full carbon impact and identify key areas for reduction.
- Energy Transition Plan: An ongoing plan to enhance our energy efficiency and promote the adoption of renewable energy sources.

Beyond these core initiatives, we recognize that sustainability encompasses not only environmental concerns but also the **well-being of our employees**. Therefore, we have implemented several actions focused on improving the quality of life at work and promoting sustainable practices within our daily operations. These initiatives were:

- Sustainable Commuting: We have experimented with different types of bicycles to facilitate inter-site travel and encourage sustainable commuting among our employees, promoting both physical activity and reduced carbon emissions.
- Healthy Catering: We have implemented a healthy catering service, prioritizing fresh, locally sourced ingredients and promoting healthy eating habits among our workforce.
- Collaborative Gardening: We have created and maintain vegetable gardens tended by our employees, fostering a sense of community, promoting sustainable food practices, and providing a relaxing and engaging activity.

These actions, combined with other ongoing initiatives, demonstrate CRM Group's unwavering commitment to sustainable development and its dedication to creating a positive impact on the environment and society. We firmly believe that by integrating sustainability into our core business strategy and fostering a culture of responsibility, we can contribute to a more resilient and prosperous future for all.



2024 KEY HIGHLIGHTS

In 2024, CRM Group achieved remarkable milestones, driving innovation, sustainability, and growth. From launching groundbreaking pilots & projects to expanding our global reach, we continue to set new standards of excellence and impact.

Inauguration Plasma / EAF pilot furnace

In May 2024 we proudly inaugurated our **state-of-the-art plasma furnace** at the Hydrométal site in Engis in the presence of Minister Borsus. Backed by a 5 million euros investment from the Walloon Region's Reverse Metallurgy program, this cutting-edge furnace is the most versatile of its kind in Europe. Designed for the efficient **recovery of critical raw materials**, the furnace contributes to reducing significantly carbon emissions by supporting innovative processes such as melting, smelting, and fuming, in collaboration with Hydrométal. Additionally, the pilot plant plays a pivotal role in **advancing emerging steelmaking technologies**, including hydrogenreduced DRI melted in electric arc furnaces and smelting furnaces. It also supports the **valorization of slag through remelting and granulation** capabilities, positioning it as a key asset for sustainable metallurgy.

Collaboration, connecting & innovating together

CRM Group brings together world-leading companies from diverse sectors. During our Members Day, participants had the opportunity to explore our latest advancements through presentations, live



demonstrations, and engaging discussions with our experts in key areas such as **Digital Solutions & Sensors, Smart Products, Advanced Manufacturing, Materials Characterization, and Circular Economy.** The networking session fostered valuable exchanges between companies and sectors, enabling them to **share insights, experiences, and explore new synergies and collaboration opportunities.**



Revolutionizing the recycling of metals arising from decommissioned nuclear facilities

The SMELD project, launched by SCK-CEN and CRM Group, marks a significant step toward sustainable nuclear practices. With €13.5 million in funding, the initiative focuses on recycling metals from decommissioned reactors considered too radioactive for immediate recycling and yet not radioactive enough for classified disposal, reducing this current non-recyclable radioactive waste by 97%. Combining

SCK-CEN's nuclear expertise with CRM Group's metallurgical competence SMELD aims to develop an advanced processing furnace by end 2026. This innovative approach supports **a circular economy and drives sustainability in nuclear dismantling**. Through collaboration, SMELD envisions a greener, more efficient future in nuclear activities.



CRM Group's cutting-edge technology flights with Ariane 6

With our expertise in material science we created solutions critical for space applications. In collaboration with Sonaca and Walopt_aero, and supported by the European Space Agency - ESA, CRM Group has developed **innovative thermal management equipment for the electronics on an Ariane 6 satellite**. Utilizing advanced Phase Change Material (PCM) technology, our damping units are designed to store and release thermal energy efficiently, ensuring optimal performance and longevity of the rocket's electronic components. The integration of our phase change materials solution in the Ariane 6 flight marked a significant milestone in our journey towards innovation and excellence.



SA CREDIT ESA-L. Bourgeor

2024 KEY HIGHLIGHTS

Advancing towards industrial scale

CRM Group's **capacity of managing complex engineering & upscaling projects** successfully showcased in the Butterfly-project. To advance the carbon capture capabilities, of lime kilns a futuristic CO₂ concentration system for lime production has been jointly developed by Carmeuse, TECforLime and CRM Group. An industrial scale pilot facility has been engineered and erected and test campaigns run successfully in 2024.





Global Performance Excellence Awards 2024



Our expertise honoured

- International recognition of our expertise in steel rolling & work rolls: Our colleagues Sébastien Flament, Hugo Uijtdebroeks and Gisèle Walmag received the AIST – Association for Iron & Steel Technology -2024 Hunt-Kelly Outstanding Paper Award – Third Place for the paper entitled "Importance of Roll Oxide to Increase Roll Life in a Hot Rolling Mill". This 5th award in just 10 years highlights the globally recognized expertise of CRM Group's specialists in steel rolling and work rolls.
- As part of ArcelorMittal's XCarb® initiative, CRM Group has been actively involved since 2022 in the industrialization and deployment of key XCarb® products. This innovative steel, produced in an Electric Arc Furnace (EAF) using high levels of scrap and 100% renewable electricity, significantly reduces the CO₂ footprint of projects, products, and finished goods. The XCarb® RRP project has received the Performance Excellence Award 2024 in the "Business Process Optimization" category—an incredible recognition of ArcelorMittal's commitment to performance excellence and a great acknowledgment of CRM Group's contribution to this initiative.

In collaboration with ArcelorMittal, CRM Group is playing a key role in developing an innovative Building Integrated PhotoVoltaic (BIPV) solution for commercial and industrial roofs. Designed for steel-sloped roofs, Helioroof is a lightweight, eco-friendly, and efficient solution, perfectly suited to modern construction practices. Helioroof integrates high-power crystalline solar modules, some of the largest ever produced for terrestrial applications and is the winner of the 2024 Innovation Industry Award in the Photovoltaics category.

European projects

CRM Group is actively involved in 24 European projects from which 7 of them under the coordination of CRM Group. In 2024, 5 new RFCS projects and 3 new Horizon Europe projects have been launched.



KEY FIGURES 2024





INCOME BY FINANCING



TOTAL INCOME (CRM NPO): 48,5 ME

14



GENDER BALANCE

CRM GROUP: 280 PEOPLE



DIVERSITY BALANCE



CRM GROUP: INNOVATING TO TRANSFORM INDUSTRY

At CRM Group, our mission is simple yet ambitious: to innovate, support industrial transformation, and create value for our partners. Every day, we push the boundaries of metallurgy, advanced manufacturing, energy transition, and circular economy to deliver solutions that accelerate industrial performance and open new market opportunities.

Supporting industry with cutting-edge solutions

We work hand in hand with our members and industrial clients to develop and implement high-impact technologies. From laboratory research to full-scale industrial deployment, our teams translate scientific discoveries into tangible solutions, helping companies optimize processes, enhance materials, and stay ahead of market demands.

Innovation at the core of our strategy

- De-risking new technologies: Our pilot lines and semiindustrial facilities allow us to bridge the gap between R&D and industrial reality, accelerating the adoption of breakthrough innovations.
- Driving sustainability: actively integrate We digitalization, decarbonization, and circular economy principles into our projects to help industries reduce their environmental footprint while maintaining competitiveness.
- Creating market opportunities: By developing advanced materials, smart coatings, and innovative manufacturing processes, we open new possibilities for industrial players in aeronautics & aerospace, steel, energy, defense, and beyond.

A collaborative ecosystem for maximum impact

We believe that collaboration is key to innovation. As part of a dynamic network of industrial leaders, research institutions, and public organizations, CRM Group is a catalyst for change, ensuring that new technologies deliver value at every stage of industrial transformation.

With over 280 employees and a €48.5M budget, CRM Group continues to reinvent industrial processes, strengthen the metals and materials industries, and support companies in their evolution.

TOGETHER, WE ARE SHAPING THE INDUSTRY OF THE FUTURE.





«A fundamental shift is necessary in the way our societies produce, transform and use energy. Industrial processes, mobility and construction solutions are fundamentally reinvented to reduce environmental impact through integrating cleaner energy sources ranging from upgraded waste materials to renewables».

Jean Borlee Platform Manager Energy shift

Decarbonization of steelmaking

To support the **steel industry** in achieving its decarbonization goals, **CRM Group** is actively engaged in three key pathways:

- Reducing the carbon footprint of existing Blast Furnace (BF) operations.
- Transitioning to Direct Reduction (DR) processes, replacing coke and coal with natural gas and, eventually, hydrogen.
- Increasing the share of Electric Arc Furnace (EAF) steelmaking, which relies on recycled scrap.

Decarbonizing the blast furnace route

Carbon emissions from blast furnaces can be reduced by **optimizing processes** and replacing fossil-based fuels with renewable alternatives or hydrogen. To support this transition, **CRM Group** continuously improves its **sintering and blast furnace modeling tools**. The **Mogador** model, for example, has been adapted to simulate higher hydrogen levels in reducing gas, with further calibration underway in the **H2TRANSBF project**. This initiative, co-funded by the RFCS, aims to achieve a **25–35% reduction in CO₂ emissions**.

CRM Group is also developing **alternative reductants** from biomass and waste materials. The **SMART Life project** explores the use of **recycled plastics**, waste fractions, and bio-based materials to replace coal. As part of this work, **CRM Group** has built extensive expertise in **thermal processing of waste-derived reductants** and is supporting ArcelorMittal in the next phase of the **Torero plant in Ghent**, where bio-coal from waste wood will be used in blast furnaces. Future developments will extend this approach to **alternative reductants** from **plastics and textiles**.

Direct reduction

During the transition to hydrogen-based steelmaking, sinter plants will continue to play a critical role in recycling by-products and adapting to varied iron ore grades. The TRANSinter project, co-funded by RFCS, focuses on using by-products from BF and DR routes to produce sinter feed for DR processes, reducing reliance on high-grade iron ore pellets.

CRM Group has developed a **characterization tool** for **DRI assessment** (metallization rate, porosity, crack distribution) based on previous in-house developped sinter mineralogy characterization.

Expanding direct reduction capabilities

To support the development of **low-carbon ironmaking**, **CRM Group** is actively involved in the **HBI C-Flex** and **Safe H-DRI** projects, where it **produces and characterizes DRI samples** with different carbon contents. These samples replicate various **DR shaft technologies (Midrex, EnergIron)** and iron ore grades, with **testing in both natural gas and hydrogen-based conditions**.



Metallization degree



Samples taken at different heights from lab scale reduction furnace



DRI samples (stocked under vacuum) produced with the HUGE reactor

To further enhance its capabilities, CRM Group has developed **pilot-scale reduction reactors**:

HUGE reactor, used for Direct Reduction testing.

 RACHEL reactor, commissioned in early 2025, enabling batch production of over 50 kg of DRI under commercial DR conditions.



Enhancing Electric Arc Furnace (EAF) operations

CRM Group has also recently commissioned a **plasma furnace** (125-litre crucible), allowing the evaluation of **DRI behavior in EAF or SAF conditions** under industrially relevant conditions.

We continuously improve our **EAF modeling tool**, which simulates various operational modes, from full scrapbased melting to hybrid scrap/DRI charging.

This model, extensively validated at the industrial scale, is now evolving into a **digital twin of the pilot furnace**, providing **real-time insights into furnace operations**. As part of the **Walloon-supported LANCE project**, the model is also being extended to simulate **stainless and high-alloy steelmaking**.





Electrification of high temperature furnaces

Electrification of thermal processes enables decarbonization by replacing fossil-fuelled combustion in high-temperature, high-power furnaces with partial or total electrical heating, eliminating direct CO₂ emissions while maintaining industrial efficiency. The application of electrical technologies brings new challenges in the operation of the industrial furnaces. CRM Group brings its experience in industrial processes, materials science and metrology to assist its industrial partners (AGC Glass, APERAM, John Cockerill) in this energy shift in the frame of the HECO2 project dedicated to electrification.

APERAM Châtelet is installing electrical heating elements in the soaking zone of its slab reheating furnace. Such an adaptation will rise the oxygen level in the furnace atmosphere. CRM Group is therefore studying the impact of these changes on the product **quality**. Both small scale thermobalance lab test as well as pilot rolling trials reproducing the thermal cycle and atmosphere in actual burning and electrical heating operation conditions show exacerbated oxidation of the steel surface.



ENERGY SHIFT

In collaboration with John Cockerill Energy, we are developing an electrified version of Multiple Hearth Furnaces (MHF) for various thermal processes. In 2024, CRM Group assessed the impact of electrical heating on processes and products using a pilot batch furnace, combining results with a thermal model to engineer the electrification of its continuous pilot MHF. Key steps included calculating power needs, designing heating element placement, selecting radiant tube materials, and initiating reversible structural modifications to maintain gas burner compatibility. The electrified furnace is targeted for operation in 2025, enhanced with advanced instruments such as endoscopic camera for furnace inside visualization, flue gas flowrate and composition monitoring and raw material and products imaging and AI for improved control, predictive maintenance, and process monitoring.





Specific camera to be fitted on a selected hearth for vision of the product and quality assessment



Efficient heat recovery

Traditional steelmaking processes are major contributors to global CO₂ emissions due to reliance on fossil fuels. The Horizon Europe-funded **HURRICANE project** aims addressing this by developing technologies to **capture and reuse industrial heat**, ultimately creating a circular heat hub at ArcelorMittal Ghent. Over the past year, the project has made significant progress, including developing and testing **heat exchanger prototypes for the hot strip mill and heat grid connection**. A 90kW coil simulator was built to test radiation heat capture from 600°C hot rolled coils, enabling precise performance measurements of new heat capture technologies. Advances were also made in coatings, construction techniques, and a 3D radiation model for scaling to industrial applications. Initial trials showed strong potential for high-temperature radiation to capture substantial energy.

Carbon Capture Utilization & Storage (CCUS)

Capturing CO_2 is crucial for energy-intensive industries to reduce greenhouse gas emissions, align with climate goals, and transition toward sustainable operations without compromising productivity.

The HECO2 project portfolio, co-funded by the Walloon Region in the frame of the Relaunch and Resilience plan, has the ambition to decarbonize the heavy industry in Wallonia.

The first important step related to CCUS is the mapping of CO_2 emissions (on complex, multi-stack industrial sites), the selection of the best CO_2 capture location(s) on each site and possibly the **conversion of industrial processes** to render them compatible with CCUS techniques and to limit the final costs of CO_2 capture. **CRM Group** and Carmeuse are notably joining forces for the groundbreaking "Butterfly" project, a futuristic CO₂ concentration system in lime production. In 2024, the construction of the first-of-a-kind industrial demonstrator kiln was completed in Carmeuse Seilles and has been operated 24/7 by CRM Group personnel to perform two initial test campaigns. Two additional campaigns will be carried out in 2025.

Within the frame of the same HECO2-project, **CRM Group** is also actively expanding its CO_2 -capture testing capabilities, with two large pilot plants nearing completion. The first, known as PiCaSSo, is dedicated to testing solvent absorption processes. Fully revamped in 2024, this plant will initially test amine-based industrial CO_2 solvents under conditions replicating those found in the facilities of the project's industrial partners Carmeuse, AGC-glass, APERAM and Prayon.



BUTTERFLY demo plant finalised in Seilles (mid 2024)

The team of CRM operators during a training at Carmeuse-Seilles



The second large pilot plant for CO₂-capture utilizes a promising **anti-sublimation cryogenic process** developed by Chart-SES in the USA, chosen by the project's industrial partners. This **mobile pilot plant**, housed in a marine container, will be operated by **CRM Group** in 2025 **at the four industrial partner sites**. It will be connected to the selected fume ducts at each site to ensure full representativity of operating conditions.

CIRCULAR ECONOMY



«Our process-productapplications approach gives us an unparalleled vision and unique capabilities to tackle circularity issues whilst conceiving new multilayered components for batteries or electrolyzers. By already anticipating second life or recyclability at end of life we integrate resource efficiency and eco-design in our daily work.»

Bernard Vanderheyden Platform Manager Circular Economy

Scrap melting to assess quality improvement after scrap sorting and processing

Circular sourcing of steel & ferro alloys

Research into circular steel and ferro alloy sourcing is crucial for optimizing resource efficiency, reducing environmental impact, and ensuring a sustainable supply chain in the steel industry.

Steel scrap is becoming increasingly important in steelmaking due to its sustainability, cost efficiency, and reduced carbon emissions. As demand for greener practices grows, **innovations in scrap processing** will be key to meet the climate goals and producing high-quality steel.

Despite its abundance, the limited availability of high-grade scrap highlights the need for **advancements in sorting and refining technologies**. This topic on 'CirculArity Enhancements by Low quality Scrap Analysis and Refinement' is dealt with in the Horizon Europe **CAESAR** project under the coordination of CRM Group. Scrap melting trials have been conducted at CRM Group to evaluate the effectiveness of advanced scrap sorting technologies, ensuring that **high-quality**, **uncontaminated** scrap

is obtained for use in the steel production process.





CIRCULAR ECONOMY



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Pre-screening zinc distillation trial in smaller vacuum furnace

The development of an innovative combination of **sensors**, **robotics**, **and artificial intelligence** is crucial to support advanced metal sorting tools. In the ECWALI project, part of the Reverse Metallurgy+ program and supported by the Walloon Region under the Relaunch and Resilience Plan, CRM Group is collaborating with Comet Traitements and University of Liège to set up an **on-line analyzer** using Laser Induced Breakdown Spectroscopy (LIBS). This analyzer will **monitor the composition of stainless steel and aluminium scrap in real time**. By combining the LIBS-results with data from other sensors, the system will precisely identify and separate different scrap grades (e.g. Mo containing stainless steel) and direct them towards the corresponding flows, ensuring maximum value without quality loss.

As the use of scrap in steel production increases because of the need to decrease CO_2 emissions, understanding the **impact of residual elements on steel product properties** becomes crucial. To address this challenge, CRM Group has launched multiple research initiatives. One focuses on assessing how these new chemistries influence behavior during hot rolling,



200 L vacuum furnace

Purified zinc ingots

contributing to the advancement of predictive models. In 2024, the investigation of austenite flow behavior via torsion testing focused on dynamic recrystallization. Another initiative MetConZero, co-funded by the RFCS program, investigates the impact of residual elements on the properties of key steel grades, including IF, Dual Phase, and high-carbon steels. These efforts are essential to ensuring consistent quality, performance, and sustainability in modern steel manufacturing.

With the support from the Walloon Region and expertise from our PUREZINC project partners, our 200L thermal preconditioning pilot furnace has been fully equipped with condensers, a zinc tank, a vacuum pumping group, and a supervision system. This facility enables the recycling and purification of zinc scraps from various sources to produce high-guality industrial zinc ingots for automotive, batteries, and medical applications while complying with new EU regulations on Pb and minimizing Cd and other elements such as Fe, Al, Ni, Cr. Cu. In. Bi. and Sn. Additionally, with support from the Reverse Metallurgy Program, the multi-purpose pilot has been upgraded with a neighboring post-combustion unit, which can be connected via a rotating pipe and an accessory conical lid. This setup enables the pyrolysis of contaminated scraps before either vacuum de-zincing of steel scrap or vacuum purification of zinc scrap.



Thermal preconditioning pilot used for scrap pyrolysis :

Lid to collect pyrolysis gas – sketch of furnace in pyrolysis configuration – post-combustion chamber

CIRCULAR ECONOMY

As part of the PyroTeCnIC project under the Relaunch and Resilience Plan, we are exploring ways to **convert manufacturing residues into alternative sources of alloying elements for foundries and for the steel industry.** This could **reduce reliance on primary ferroalloys**, which have high costs, volatile prices, and significant carbon footprints. For example, grinding unsorted steel shavings from a Walloon training centre allowed after sieving the separation of highly alloyed materials in the fine fraction thanks to their higher brittleness. In another case study, a synergy was discovered between oily sludge from machining special steels rich in alloying elements and chromium-rich iron foam. While neither material could be briquetted on its own, mixing them in specific proportions resolved this issue. The resulting briquettes are rich in chromium and other elements, contain minimal oily residues, and are easy to handle and load into a melting furnace.



Initial turning samples

Separation of high alloyed materials in the finest fraction (<5mm) after grinding & sieving

Towards zero-waste metallurgical routes

To make the steel industry more CO_2 -neutral and achieve zero waste, raw materials must be used as efficiently as possible, and new circular solutions for recycling must be developed and validated prior to industrial implementation.

The production of DRI (Direct Reduced Iron) out of iron and zinc bearing by products is studied in the ZincVal project, co-funded by the RFCS-program. New technologies are developed ensuring high resource efficiency by maximizing the extraction of value from raw materials and for the reuse of low-zinc residues (such as dusts and sludges) generated in current and future steelmaking processes. Additionally, the developed technologies should be also applicable to historical deposits, allowing steel producers to recover land areas needed for redesigning their processes towards carbon-free or low-CO₂ steelmaking. CRM Group is conducting laboratory and pilot-scale investigations of the Rotary Hearth Furnace and Rotary Kiln processes, with a particular



Preprocessing for improved recovery : granulation of dust & sludge mixture

focus on how improved material preprocessing can enhance the efficiency and selectivity of zinc recovery in process fumes.

The Horizon Europe project ZHYRON is developing an innovative process to valorize Fe-rich, Zn-containing by-products using green hydrogen as a reductant and green electricity as the energy source. The resulting DRI

products will meet industry standards, while zinc will be recovered as a **high-purity zinc oxide** concentrate. In 2024, CRM Group investigated the cold agglomeration of fine by-products through extrusion. The extruded products were subsequently successfully reduced in a lab-scale trial using 100% hydrogen under low pressure and low temperature.





Extruded products before and after ZHyRON reduction



Slag processing

The steel industry's **shift toward carbon neutrality** will significantly alter production processes, **leading to new slags** making up 10–30% of metal output. Predicting slag properties, studying interactions, and developing slag engineering solutions to ensure their continued valorization in cement and other markets is thus crucial to support this transition.

CRM Group supports European industries to tackle these challenges by combining expertise with advanced tools, including thermodynamic and CFD modelling, in-house EAF models, characterization labs, hightemperature furnaces, a pilot-scale plasma furnace, and a dedicated **dry slag granulation system**.

We developed our own pilot dry slag granulation system for the plasma furnace. The design process began with in-house CFD modelling of the granulator to optimize the air jet and nozzle shape for optimal particle breakup. Key equipment, including a preheated slag runner between the plasma furnace and granulator,

Pilot scale dry slag granulation in operation

a shooting chamber, and an off-gas extraction system was then designed and installed. A commissioning trial was conducted with next-generation slag (DRI-EAF slag) after its granulation potential was assessed and validated through thermodynamic calculations (FactSage). Over 200 kg of slag was melted, poured and successfully granulated.

This new dry granulation pilot facility is supporting several ongoing projects focused on slag research. GEOSLAGS (Walloon-funded GreenWin) aims to **enhance the reactivity of stainless steel slag** through its physical modification, enabling the development of **fully mineral geopolymer-based sandwich panels** for the construction sector. Meanwhile, in the InsGeP, RFCS co-funded project, CRM Group is advancing knowledge on next-generation carbon steel slags. This includes using its EAF model to predict how DRI quality and rate affect future slag properties, followed by pilotscale production and granulation.



Effect of air jet speed on the initial liquid breakup – A: Subsonic air jet / B: Sonic air jet / C: Supersonic air jet

Recovery of strategic and critical raw materials

The European Critical Raw Materials Act (CRMA) aims to secure the supply in Critical Raw Materials (CRM), which are needed for the Energy and Digital transitions, but also for strategic sectors like Aerospace and Defense.

One of CRMA's goals is to advance recycling processes, which requires safe handling of toxic materials like black mass from end-of-life batteries. To ensure this, CRM Group has equipped its recycling facilities with a unique clean room capable of processing such materials at a 1-tonne scale under fully safe conditions. Features include negative pressure (-15 Pa), constant air renewal, filtered air extraction, dust collection at emission points, air quality monitoring, dedicated personal protective equipment, and access through a decontamination zone with an air shower.

In the frame of the Reverse Metallurgy project 'Plasmetrec' co-funded by the Walloon Region, CRM Group has collaborated for years with HydroMetal to co-develop innovative recycling processes that efficiently combine pyrometallurgy and hydrometallurgy for the **sustainable recovery** of non-ferrous metals, with a focus on Critical Raw Materials essential for the energy transition. In 2024, the upscaling of the most promising lab-scale processing concepts began, with 1-tonne scale trials in CRM Group's plasma furnace. The first material was briquetted and tested for precious metal recovery via smelting reduction in the plasma furnace, with several additional trials already planned for 2025 in the PyroTeCnIC project, part of the Reverse Metallurgy+ program.



Clean room for safe handling of toxic materials



1 tonne scale pilot trial to recover critical Raw Materials

ADVANCED MANUFACTURING


«Each day, we develop innovative manufacturing solutions for our industrial partners thanks to our unique Direct Metal Deposition and coating tools. The development of green and sustainable manufacturing is a fast growing share of our activities devoted to repair of existing parts and development of innovative coatings to enhance the lifetime of products.»

Cédric Georges Platform Manager Advanced Manufacturing

Advanced manufacturing for durable and sustainable part

REMADE is part of the Reverse Metallurgy + co-funded by the Walloon Region in the Relaunch and Resilience program, addressing the circular economy of metals in Wallonia. Specifically, the REMADE project aims to add value to recycled metals by developing high-value products through various production and utilization channels for metal powders. In the axis dealing with **increasing the durability and lifespan of manufactured parts and additive repair of worn or damaged metal components**, CRM Group has developed with its **industrial partner Westinghouse** the **repair of metal components using robotized Laser Metal Deposition (LMD)** technology, especially for the **nuclear sector**. It was a great opportunity to demonstrate the LMD technology on a representative mock-up and to illustrate how LMD technology can be used for repairing and extending the life of high value components.



Repair of components for nuclear sector with laser metal depostion

Cold Spray is another technology perfectly aligned with industrial needs for **repairing and protecting components without degrading their properties**. The technology allows metallic materials to be deposited at high speed without heating the objects, preserving the metallurgical properties of the materials while ensuring excellent adhesion. CRM Group recently installed a high-pressure Cold Spray equipment within its Advanced Manufacturing platform. In partnership with VLM Robotics, we demonstrated the ability to apply a thick copper coating on large (XL) parts. Using the **Cold Spray combined with robotic system and rotary table** for handling heavy, bulky objects we showcased the process's flexibility and precision, opening the door to applications in demanding sectors like **aeronautics**, **aerospace and energy**, where part protection and durability are crucial.

Another axis in the REMADE project aims to **add value** to recycled metals by developing high-value products through various production and utilization channels for metal powders. Aiming at adapting and re-using metal materials in high added-value manufacturing processes, CRM Group has set-up a preparation step for producing powders from end-of-life metal components. To produce feed material for the atomisation tower of ULiège-Greenmat,specific molds were designed to cast stainless steel and aluminum scrap into cylindricalthoracic ingots.



Demonstration of the cold spray technology

Casting in mold

Advanced manufacturing for aerospace and aeronautic applications

As part of the European Space Agency's GSTP project, DiMaLIR, CRM Group is building on a previous collaboration to 3D-print a 1-meter diameter Launch Interface Ring in partnership with Sonaca and Cenaero. This project presents several challenges, including mastering aluminium printing, leveraging the full capabilities of our 6-axis robot equipped with an external 2-axis manipulator, and dynamically adjusting laser spot sizes based on the specific features of each section being printed.



Left: CAM view of the printing strategy Right: first printed layers to assess the process stability

Developing aluminium compositions for use in direct energy deposition processes, including LMD, WAAM, and WLAM is the objective of another ESA GSTP supported project. In addition to process compatibility, the alloy must meet key requirements such as high resistance to stress corrosion cracking, high ductility, and compatibility with anodization processes. Through a series of both standard and specially designed tests, CRM Group has benchmarked various compositions and identified one for full characterization next year.

Studving the assembly of additively manufactured parts through welding is crucial to ensure structural integrity and optimal performance in demanding applications. This is especially important for producing larger and more complex parts that cannot be easily created using conventional additive manufacturing techniques. Such advancements are vital for lightweight applications in the aerospace and automotive industries. The WELDALAM project, a CORNET initiative, co-funded by the Walloon Region, focused on developing joining concepts for connecting metal-printed parts to each other and to conventionally manufactured high-strength aluminium components. It involved various welding techniques, and design, material, and process guidelines were developed for industrial users to enable the future use of welded additive manufacturing components. Two demonstrators, defined by the user committee, were realized and showcased at a conference in Dresden with Walloon and German industrial partners.



Left: Demonstrator 1: AM manufactured heat pipes welded with laminated aluminium sheets Right: Demonstrator 2: AM manufactured part welded on a flanae



DIGITALIZATION



«Wisely used, we believe that digital technologies are fabulous tools to empower the energy transition, the circular economy, the advanced manufacturing and the industrial efficiency. Therefore, we develop innovative smart products and sensors meeting specific demands and we integrate customized IoT and AI solutions in the processes and products of our customers to create more value.»

Catherine Archambeau Platform Manager Digitalization

Digitalization and advanced manufacturing

The Horizon Europe DILAPRO project aims ensuring that complex products created by laser technologies, such as additive manufacturing, meet industrial requirements for design, quality, cost, and sustainability. A **digital twin software** is being developed **to qualify and certify the properties** of these parts. CRM Group supports this development by integrating sensors into the DED-LMD equipment, HYMAX, enabling full monitoring during printing and will manufacture demonstrators. Full monitoring during printing on HYMAX is possible thanks to two thermal cameras, a coaxial pyrometer, and a laser triangulation sensor to measure layer height and reconstruct the part using point cloud data. Additionally, laser power can be automatically checked offline, and soon, the powder jet will also be automatically checked offline. In 2025, the focus will be on machine learning and implementing environmental monitoring, with temperature, humidity, and gas flow measurements to be introduced soon.





DIGITALIZATION

Digitalization and artificial intelligence for the steel industry

Digitalization and sensor integration are transforming the steel industry by enabling real-time monitoring and data-driven decision-making, leading to enhanced efficiency and product quality and facilitating predictive maintenance and more sustainable processes.

A digital twin for work rolls for hot rolling facilitates a closer monitoring and analysis of work roll lifetime and enables the prediction and detection of internal roll defects, incidents and enhancing product quality by online profile and friction calculations. In a collaborative regional project co-funded by the Walloon competitiveness cluster MecaTech, and in collaboration with Marichal Ketin, UCL, Pepps, and Taipro, sensors have been integrated in laboratory work rolls (SmartRoll – MecaTech). The temperature, torque, and acceleration from the work roll are measured and data transmitted in real-time to a cloud platform to create a digital twin of the work rolls to follow the life cycle. The prototype instrumented work rolls were successfully tested in semi-industrial hot rolling on CRM





Testing the instrumentals rolls on CRM Group's pilot hot roling line

Group's pilot facilities. The collected data, including sensor readings and production data, can be used as input for on-line models. Based on these promising results Marichal Ketin is developing a prototype instrumented finishing work roll for an industrial hot strip mill.

Advanced digital solutions combined with artificial intelligence allowing to enhance inspection and improve operator safety during maintenance is the objective of the VISMAIN project. In this project, cofunded by the RFCS-program, a new tool to assist operators in the visual inspection of a hot rolling stand is under development. A first prototype was designed and built by CRM Group and tested in our laboratories before being integrated in a hot rolling stand of the DSP mill in Tata Steel Ijmuiden. The results are highly promising: high-quality images have been captured, enabling the detection of defects in cooling system nozzles.

The OLACSKIN project, co-funded by the European RFCSprogram is a nice illustration of how **digitalization**, **sensors and artificial intelligence assist in developing sustainable processes**. The replacement of the current cleaning technology for skin pass rolls, that consumes significant water and detergents at high pressure, by an innovative approach utilizing laser cleaning, requires an effective inspection system to detect zinc fouling and staining on the rolls. By identifying areas with contaminants with an optical detection system, **OLM On-Line Microscope supported by AI**, the laser cleaning process can be precisely applied only where needed, ensuring efficient and environmentally friendly maintenance.



OLACSKIN project team



Image processing applied on OLM pictures for zinc detection on work roll surface

Printed and 3D additive electronics

CRM Group is developing processes for printed and additive electronics, enabling the integration of connected devices and sensors onto 3D objects. With expertise in metallic and related materials, CRM Group solutions meet the strict demands, including high-temperature operation, resistance to corrosive environments, and compatibility with circular product designs. Our innovations find their applications in the steel industry, the aeronautic and defense sector and automotive manufacturing while aligning with ecodesign principles to meet the growing demand for connected, interactive, and sustainable products. CRM Group represents the Benelux printed electronic activities in AFELIM, now part of an Alliance of Components and Systems for the Electronics Industry, ACSIEL, a professional organization which brings together all the players in the value chain of the electronics industrial sector in France.



2024 has seen a major step in the collaboration between CRM Group and John Cockerill Defense with the successful achievement of the VIRGA project (Mecatech program). The primary objective of the project was to develop an **advanced camouflageintegrated solution** that combines both 'active' and 'passive' approaches. The passive approach focused on the development of a specialized paint with modified emissivity, enabling controlled responses to InfraRed (IR) detectors and altering the visible geometry of the object's surface. The active stealth approach involved the creation of a controlled matrix of heating elements using printed electronics. A single-cell heating element was optimized, successfully upscaled, and adapted to complex 3D geometries to cover a prototype body. Furthermore, an electronic control system was designed to regulate individual heating cells, allowing precise control over their operation and heat output. This system enabled the transmission of custom thermal patterns to the heating matrix, which produced specific thermal signatures visible to IR cameras. Building on the achievements of this project, a follow-up initiative in collaboration with John Cockerill has been launched to further optimize the design and functionality of the system.

In the project 'Additively Manufactured Components with Embedded Sensors" (ACES) co-funded by the Walloon Region (Win4Collective program), we have successfully demonstrated advanced surface preparation capabilities for 3D metallic objects produced using Selective Laser Melting (SLM) techniques.

The direct integration of printed sensors onto these surfaces for structural health monitoring has been **showcased**: sensors such as ThermoCouples (TC), Resistance Temperature Detectors (RTD), strain sensors, and Radio-Frequency IDentification (RFID) sensors were successfully integrated onto SLM objects, such as 3D turbine blade structure using specialized sensor printing techniques.

A reliable traceability solution has been developed using RFID technology to enable end-to-end monitoring of complex steel products, from production in the steel mill to their use and eventual reuse. Active support was provided to the mill team to assist with the integration of RFID and connected systems. Measurement campaigns conducted on the production site's internal stock confirmed the reliability of the RFID solution. In parallel, new RFID solutions and developments were tested in CRM Group's lab to further explore system integration in steel elements and address critical life cycle issues.





Intelligent Stealth printed solution on John Cockerill Defense turret

OUR SUSTAINABLE INDUSTRIAL SOLUTIONS, APPLICATIONS & SERVICE OFFER



«Our in-depth knowledge of metals, with a particular focus on steel, combined with a strong capacity for upscaling and fostering synergy between process, product, and application, enables us to deliver tailored solutions that serve our customers needs with excellence.»

Griet Lannoo CTO and R&D program coordinator

Sustainable solutions for the steel industry

The steel industry faces a growing need to develop processes that are at the same time **efficient and sustainable**, as it strives to remain competitive while reducing environmental impact and optimizing resource utilization.

To improve product quality, reduce downgraded coils and reduce mill down-time, the SmartCool project (EU co-funded in the RFCS program) aims at **improving strip steering in hot strip finishing mills and reducing rolling incidents such as cobbles**. One of the primary causes of strip steering issues in finishing mills is temperature distortions across the width of the transfer bar. Hot shoulders and asymmetric temperature evolution can result in uneven deformation of the strip, leading to threading refusals, cobbles, and strip steering problems.

To optimize the finishing process, a **new transfer bar cooling actuator has been developed to address temperature distortions**. This actuator leverages real-time temperature measurements captured just before the transfer bar with a smart control algorithm to apply smart, selective cooling. The innovative system has been **implemented in the hot strip mill of Arcelor Mittal Belgium** and is scheduled to become operational in 2025.



Smart selective transfer bar cooling implemented in ArcelorMittal Ghent

OUR SUSTAINABLE INDUSTRIAL SOLUTIONS, APPLICATIONS & SERVICE OFFER

Since July, a new RFCS co-funded project called EdgerRolls has been launched, coordinated by CRM Group and involving the R&D and production teams of both ArcelorMittal and Tata Steel in collaboration with the roll manufacturer Marichal Ketin. The project aims to secure the supply of high-quality tapered edger rolls for European hot strip mills by adapting both existing and emerging manufacturing methods for the production and rebuilding of edger rolls. A second key objective of the project is to enhance the performance of edger rolls through improved cooling strategies, optimized lubrication, caliper geometries, and process parameters. Performance improvements will be verified using tools developed during the project, including an adapted inspection tool for monitoring degradation and an online profile measurement system.

In the field of **pickling**, CRM Group coordinates the RFCS co-funded research project InnoPick, which focuses on **developing a sustainable process to eliminate hazardous substances like hydrochloric acid**. As part of this initiative, CRM Group is developing a **highturbulence pickling module** based on the Water Pillow Cushion (WPC) and High Turbulence Low Pressure (HTLP) concepts. The module's performance was assessed by measuring the Heat Transfer Coefficient (HTC) to evaluate the impact of strip velocity, liquid pressure, the distance between the module and the strip, and the module's design. In the field of **cold rolling**, CRM Group is participating in the RFCS co-funded BURWear research project, which aims **to master the wear behaviour of back-up rolls in cold rolling mills**. To achieve this objective, the BURWear consortium is developing a wear evolution model. To feed the model with data which cannot be generated industrially, **CRM Group has developed a laboratory trial able to simulate the industrial process**, enabling the testing of various back-up roll materials, hardness levels and quantitatively evaluating the influence of parameters like lubrication, rolling forces (Hertzian pressure), work roll surface conditions.



Set-up to simulate industrial cold rolling

CRM Group specialized in tailor-made material testing

Next to standard mechanical and surface properties, **CRM Group also specializes in complex combined material properties** like corrosion, forming, resistance to specific conditions (UV, high and low temperature, pressure, fire, ...) that require more extensive testing as can be illustrated by the helium leak tests carried out under cryogenic conditions on gaskets for Safran Aero Booster. Safran Aero Booster commissioned CRM Group to conduct performance test of static gaskets intended for the isolation value of the Vega Rocket new evolution. Two Bread Bord Models (BBM) were developed by Safran to test several dimensions and suppliers. The CRM Group's hydraulic department, specialized in helium leak testing under extreme conditions, was entrusted with the test campaign.

In a first step, CRM Group has developed a tailor-made pneumatic press to mount the gaskets in the BBM according to Safran's specifications. The test campaign, conducted over several weeks, simulated the service conditions to determine the helium leak rates of the gaskets at varying pressures, both at room temperature and in cryogenic conditions (liquid nitrogen). The results of these fatigue tests allowed Safran to confirm that the chosen gaskets met the performance requirements. Furthermore, the tests revealed that one gasket significantly outperformed the other, enabling Safran to make a confident choice for equipping the isolation valves of the European Vega Rockets.

Another example of CRM Group's capacity to develop specific test set-ups can be found in the Stress Corrosion Cracking (SCC) tests. These tests determine material's sensitivity to the simultaneous effects of tensile stress and corrosive environments. SCC and control samples undergo 30-day immersion/drying cycles before being analyzed through tensile testing and microstructure examination to assess their susceptibility to SCC. The test follows ECSS-Q-ST-70-37C, ASTM G44, or DIN 50908 standards and meets specific customer requirements. It has been widely used to evaluate welded products in scientific studies on material sensitization to SCC. Recently, a new setup has been developed for rapid qualitative SCC screening.



Tailor-made test set-up for He-leak testing



Stress corrosion test capacities

INNOVATIVE SOLUTIONS TO HELP YOU IN YOUR SECTOR

We focus on providing solutions that address the specific challenges faced by our customers in different industries, promoting their success through innovative, efficient and sustainable approaches from ideas to implementation.

Metal production & application: our historical core

Since its foundation, **CRM Group** has been a leader in steel and non-ferrous metallurgy R&D, working closely with industrial partners to develop high-performance materials, coatings, and manufacturing processes. Our work enables industries to enhance efficiency, durability, and sustainability in metal production while addressing the challenges of decarbonization, circular economy, and digital transformation.

Expanding horizons: beyond metals

While metal production remains at the heart of our activities, CRM Group has **expanded its expertise** to **support a wide range of high-tech industries**, offering tailored solutions for **emerging challenges in advanced materials**, **energy**, **and digital manufacturing**.



Aeronautic & space

Our lightweight alloys, functional coatings, and additive manufacturing solutions enhance the performance and longevity of aeronautic & space components, addressing extreme conditions and weight reduction challenges.



Hydrogen & energy transition

CRM Group is actively involved in hydrogen technologies, supporting the shift towards low-carbon energy through hydrogen production and storage, fuel cell materials, and industrial decarbonization projects.

Nuclear & highperformance materials

We contribute to the **nuclear** sector with expertise in recycling of metals from nuclear dismantling high-temperature materials, radiation-resistant coatings, and structural integrity assessment, ensuring safety and durability in extreme environments.

Defense & security

Our R&D in advanced metallurgy, coatings, and material characterization is critical for defense applications, including armor materials, corrosion-resistant alloys, and impact-resistant coatings. A partner for cross-industry innovation



Construction & infrastructure

CRM Group develops innovative metal solutions for sustainable building materials, improving durability, energy efficiency, and recyclability in modern infrastructure projects.

Printed electronics & smart materials

Combining metal-based materials with advanced electronics, we pioneer integrated sensor technologies, conductive coatings, and functionalized surfaces for applications in aeronautic, automotive, and digital industries.

Industrial decarbonization

CRM Group supports industries in reducing carbon emissions by developing low-carbon processes, alternative reductants, and electrification strategies for high-temperature furnaces. CRM Group's multidisciplinary expertise, state-of-the-art pilot lines, and strong industry partnerships allow to bridge the gap between research and industrial implementation. By integrating metals, energy, and digitalization, we enable industries to stay ahead of technological transitions and create a more sustainable, efficient, and resilient future. Zoom on Walloon Innovation for Green Skies **WINGS**





Advancing aeronautics innovation at CRM Group

CRM Group has been actively engaged in **innovative aeronautic R&D**, collaborating with key industry players like Sonaca, Cenaero, Safran Aero Boosters, Any-shape, and Multitel. Our research focuses on **additive manufacturing**, **printed electronics**, **traceability solutions**, **and resource efficiency**, helping to enhance **aircraft performance**, **reliability**, **and sustainability**.

Additive manufacturing & surface treatments

Together with **Sonaca and Cenaero**, we explored the feasibility of **3D-printing 17-4PH steel** onto pre-existing components, analyzing material properties, interface strength, and deformation risks. Additionally, in partnership with Safran Aero Booster and Any-shape, we assessed **surface finishing techniques** for **Ti6Al4V 3D-printed oil tanks**, ensuring compatibility with **non-destructive dye penetrant inspection**.

Printed electronics for ice protection

To improve aircraft de-icing systems, we developed printed heating solutions in collaboration with Sonaca, applying thermal spray wire arc and screenprinting technologies. These methods successfully achieved temperatures above 120°C, with ongoing efforts to reach 10 kW/m² power density for largescale deployment.

Smart factory traceability



As part of the **WINGS project**, we co-developed an RFID and Bluetoothbased traceability demonstrator with Multitel and Sonaca, designed to withstand extreme temperatures. mechanical stress, and corrosive environments. Following successful trials,



Sonaca is now considering a full-scale industrial implementation.

Resource efficiency & recycling

We also advanced recycling techniques for plasma-sprayed powders, used in abrasive coatings on aircraft stators. Through microgranulation, residual powder size was increased from 40-70 µm to over 500 µm, mitigating ATEX risks and enabling material reuse.

Future aeronautic projects

Building on **WINGS**, CRM Group is launching new initiatives to strengthen Walloon aerospace innovation:

- A Skywin-supported project with Safran Aero Boosters, GDTech, UCLouvain, MPP, and Materia Nova, developing ice-resistant blades and advanced protective materials.
- The Preformal project (COODEVIIS), focuses on precision forging automation for Safran Blades, including a CRM Group-developed tool to predict forging die wear.

Through these efforts, CRM Group continues to drive aerospace innovation, ensuring performance, efficiency, and sustainability for the future of aviation.

Zoom on Hydrogen activities



Hydrogen innovation at CRM Group

Hydrogen plays a critical role in the energy transition by offering a clean, efficient, and versatile solution to decarbonize industries, integrate renewable energy sources, and enable sustainable mobility. CRM Group actively contributes to the development of hydrogen technologies through research, pilot-scale innovation, and strategic collaborations.

Core areas of expertise

CRM Group focuses on key technological advancements in hydrogen, including:

 Hydrogen characterization, ensuring performance and reliability through advanced measurement tools.

- Hydrogen production, bridging laboratory research and industrial application with pilot-scale electrolysers.
- Material integrity verification, studying hydrogen-induced embrittlement and degradation to ensure safe and durable applications.
- Development of bipolar plates, crucial components for improving fuel cell technology.

Strategic hydrogen initiatives

CRM Group is at the forefront of several major hydrogen initiatives, supporting both regional and international innovation efforts.

 IIS e-WallonHY: As coordinator of this Walloon Strategic Innovation
Initiative, CRM Group plays a central role in fostering hydrogen technology development through collaboration with industrial and academic partners.

MaterHYum Project: This initiative, aligned with the Walloon Smart Specialization Strategy (S3) and IIS e-WallonHY, focuses on material characterization in cryogenic liquefied and gaseous hydrogen environments. The project aims to enhance the safety and efficiency of hydrogen transport and storage, with key developments including tensile and fatigue property assessments and hydrogen permeability testing. Initial trials are expected by the end of the year.

ReadHY Project: Supported by the Belgian Federal Energy Transition Fund, this project focuses on adapting existing gas infrastructure for renewable hydrogen transport while addressing key risks such as hydrogen embrittlement. CRM Group, in collaboration with Ghent University and UCLouvain, is leading the development of Dynamic Tube Rupture Testing (DTRT), a novel approach to evaluate material fatigue in gas networks under real operational conditions.



TiNTHyN Project: As part of IIS e-WallonHY, this initiative supports the development of early-stage hydrogen technologies while addressing industrial and societal challenges. The project funds 12 PhD research programs across the entire hydrogen value chain, includina:

- Production: Advancing low- and high-temperature electrolysis and plasmalysis.
- Transport & Storage: Developing new materials for hydrogen storage and pipeline transport.
- Applications: Implementing hydrogen solutions for mobility, industry, and stationary energy systems.

CRM Group plays a leading role in the scientific steering and valorization committees of the TiNTHyN project, integrating industrial stakeholders and providing access to testing facilities.

Through continuous research and innovation, CRM Group is strengthening its expertise in hydrogen technologies and supporting the transition towards a sustainable and decarbonized energy future.









First Dynamic Tube Rupture Test prototype.

Advanced Solutions for Defense and Critical Infrastructure



The protection of critical infrastructure and defense assets relies on cuttingedge technologies that integrate functional materials with advanced control systems. At CRM Group, we develop high-performance solutions tailored to the evolving challenges of modern defense, ensuring reliability, efficiency, and safety.

Our expertise in material characterization, damage analysis, smart coatings & solutions and material selection plays a crucial role in enhancing the performance and durability of defense systems. We support the sector through:

 Stealth applications: Development of active and passive coatings combined with intelligent control algorithms to enhance radar signature management.

- Advanced coatings: Our electrochemical expertise enables the development of alternative solutions to hard chromium coatings, improving durability while meeting environmental regulations.
- 3D functional coatings: Our 3D coating platform allows for the application of customized coatings on complex geometries, broadening the scope of functional surface treatments.

CRM Group has collaborated with key players in the defense industry, including FN Browning, John Cockerill Defense, Sonaca, Sabca, Safran Aero Boosters, BMT Aerospace, and Thales, contributing to innovation in materials and processes essential to modern defense applications. Strategic Innovation Initiatives: Driving Wallonia's Industrial Transformation

Wallonia's **Smart Specialization Strategy** (S3) focuses on fostering economic growth and competitiveness through innovation, research, and industrial transformation. As part of this strategy, the region supports **Strategic Innovation Initiatives (IIS)**, designed to accelerate technological advancements in key sectors. CRM Group plays a leading role in three of these initiatives:

e-WallonHY

Dedicated to advancing the Green Hydrogen Economy, e-WallonHY drives innovation across the entire hydrogen value chain—production, storage, distribution, and utilization (mobility, stationary applications, industrial processes). The initiative aims to boost local hydrogen production and usage, establish low-

carbon hydrogen ecosystems, and strengthen the position of Walloon stakeholders in regional, Belgian, and European markets. Coordinator Catherine Archambeau



WIN4C unites nearly 80 public and private organizations to establish Wallonia as the "Circular Valley of Europe" for technological materials. This initiative anticipates major changes in resource management, production relocation, repair, and recycling, ensuring Wallonia remains a leader in circular economy practices. Coordinator Lionel Fourdrinier

Focusing on Advanced Products & Manufacturing, MADEINWAL is designed to revitalize Wallonia's industrial sector by fostering innovation across the entire manufacturing value chain. Aligned with the S3 strategy, it emphasizes agile and secure production methods, advanced materials, and circular economy principles. Led by Sirris, with CRM Group as a key partner, this initiative strengthens the region's industrial competitiveness and sustainability. Coordinator Cédric Georges

PROJECTS 2024

Discover a selection of **12 key projects** that reflect the diversity of our R&D activities, from advanced manufacturing to circular economy and sustainable metallurgy.

CRESAR

Enhancing circularity in clean steel making

Circular Economy, Energy Shift

Assessment of scrap sorting & refining techniques to reduce impurities in postconsumer scrap and enhance scrap classification to keep high quality finished products





Enhancing additive manufacturing of complex products

Advanced manufacturing Digitalisation

Implementation of a digital twin on CRM Group's Direct Energy Deposition pilot line HYMAX to qualify and certify additive manufactured products during production





Securing the supply of edger rolls for European mills and improving their performance

Advanced manufacturing Sustainable steel production

Development of new inspection tools, manufacturing methods and cooling and lubrication strategies



Want to know more?

Contact us at bdservices@crmgroup.be or reach out to our CTO or R&D program coordinator: griet.lannoo@crmgroup.be



Harnessing industrial waste heat for resource efficiency & circular economy

Circular economy, Sustainable steel production

Development of solutions for recovery and re-use of industrial heat of hot rolled coils and their demonstration in the ArcelorMittal Ghent plant





Innovative & sustainable pickling technologies for flat carbon steel

Sustainable steel production

Boosting the pickling efficiency and substitution of inorganic by organic acids by high turbulent pickling solutions, strip preheating and addition of abrasive particles





Mastering the roduct properties while carbon neutral steelmaking

Circular economy, Energy shift, Sustainable steelmaking

In-depth study of metallurgical phenomena and interactions between residuals and alloying elements for the development of predictive models to assess the impact of increased use of post-consumer scrap on final properties



S ANNUAL REPORT 2024



Drastically reducing the use of water and detergents during skin pass rolling

Digitilization, Sustainable steel production

Leveraging an intelligent inspection system with innovative laser cleaning to clean skin pass rolls Read

Adapting existing gas infrastructure for hydrogen transport

Energy Shift, Hydrogen

Addressing hydrogen embrittlement by the development of an innovative dynamic tube rupture test

READ MORE







Solid-state Lithium metal batteriese

Energy Shift, Circular economy

Material development (Li anode, interlayer and Al current collector) and purification of recycled Li



Improving the operations and product quality in the hot strip mill

Sustainable steel production, Digitalization

A selective transfer bar cooling unit and intelligent control algorithm implemented in the ArcelorMittal Ghent hot strip mill

READ MORE





Supporting the transition from blast furnace to direct reduction routes by adapting the role of sintering processes

Energy shift, Circular economy

Studying new sinter types for direct reduction shafts, increased by-product recycling, the use of bio-coals, and emissionreduction strategies





Improved operator safety by combining sensors and artificial intelligence

Digitalization

Prototyping and industrial demonstration of a tool to enhance inspection and operator safety during maintenance operations in the Tata steel DSP hot strip mill

READ MORE

CRM GROUP

CRM GROUP'S PRESENCE AT KEY EVENTS IN 2024

Throughout 2024, CRM Group actively participated in numerous national and international events, reinforcing its position as a key player in industrial innovation, sustainability, and advanced manufacturing. These events provided valuable opportunities for networking, knowledge sharing, and showcasing our expertise across various strategic domains.



Mission to Norway, a threeday event bringing together key Belgian and Norwegian stakeholders to foster economic cooperation and exchange around innovation and sustainability. As part of a workshop dedicated to circular economy, CRM Group had the opportunity to present

its R&D activities, with a particular focus on the **WIN4C** - Walloon Initiative for Circular Materials, in the presence of Walloon Minister for Climate, Infrastructure, Energy and Mobility **Philippe Henry** and **AWEX - Wallonia Export & Investment Agency, CEO Pascale Delcomminette.**

This mission offered valuable opportunities for high-level networking and knowledge sharing with companies and institutions active in green technologies and circular solutions. CRM Group's participation strengthened its position as a committed actor in **international innovation ecosystems** and its ambition to support **sustainable industrial transitions** beyond Belgium's borders.





Visit of Walloon Minister Adrien Dolimont

On 15 May 2024, CRM Group had the honor of welcoming the Walloon Minister of Finance and Budget Adrien Dolimont accompanied by several industrial partners. The visit included an overview of CRM Group's latest developments in Additive Manufacturing, a guided tour of the facilities, and a networking lunch in a friendly & constructive atmosphere. This visit highlighted the importance of collaboration between public authorities, industry and research, and reinforced CRM Group's role as a key player in Wallonia's innovation ecosystem.

Mutual Learning Exercise (MLE) on industrial decarbonization

As part of Belgium's **Presidency** of the Council of the European Union, CRM Group contributed to the Mutual Learning Exercise (MLE) on industrial decarbonization. This high-level initiative gathered experts to exchange best practices and policy recommendations aimed at reducing carbon emissions in industrial processes. **CRM** Group's participation demonstrated its expertise in low-carbon steelmaking, hydrogen applications, and circular economy solutions.

Global Industrie Paris 2024

As a major event on the European industrial innovation calendar, **Global Industrie Paris 2024** offered CRM Group a prime opportunity to present its latest developments. Our teams showcased expertise in **advanced materials, digital manufacturing, and sustainable solutions** - reaffirming CRM Group's active role in shaping tomorrow's industry.

AISTech 2024

At AISTech 2024, the

international gathering point for professionals in **iron and steel**, CRM Group took part in key technical exchanges. Our experts shared **new perspectives on steel production, process efficiency, and CO₂ reduction**, underlining our commitment to driving forward the evolution of the steelmaking sector.

CRM GROUP IN THE WORLD



New plasma furnace: pioneering advanced material processing

A major highlight of 2024 was the launch of **CRM Group's new plasma furnace**, an advanced **thermal processing technology** designed to enhance **material transformation capabilities**. This breakthrough pilot strengthens our **industrial-scale research infrastructure**, supporting innovation in **pyrometallurgy and circular economy applications**.

Hannover Messe 2024

Participating in Hannover Messe 2024 - a global reference for industrial technology -CRM Group presented its latest research in metallurgy, electrification, and digital innovation. This presence highlighted our contribution to building more sustainable, efficient, and forward-looking industrial ecosystems.



ESTEP annual event 2024: shaping the future of european steel

At the ESTEP Annual Event 2024, CRM Group reaffirmed its role in the European steel innovation ecosystem. Our participation focused on advancing lowcarbon steel production, smart manufacturing, and resource efficiency, aligning with European sustainability goals.



Additive manufacturing workshop: expanding industrial applications

CRM Group organized and participated in the Additive Manufacturing Workshop, where we showcased our expertise in 3D printing, hybrid manufacturing, and functional coatings. The event provided a collaborative environment to explore the latest innovations in additive manufacturing and their impact on various industries, including aeronautic & space, defense, and energy.

A year of growth and innovation

These events reflect CRM Group's commitment to pushing technological boundaries, collaborating with industry leaders, and driving sustainable industrial transformation. Through our active engagement in international forums, we continue to strengthen our expertise, partnerships, and impact in strategic sectors.



European hydrogen week: accelerating the hydrogen economy

CRM Group actively engaged in the European Hydrogen Week, contributing to discussions on hydrogen production, storage, and industrial applications. As a key player in the e-WallonHY initiative, our teams highlighted our contributions to green hydrogen development, materials for hydrogen infrastructure, and industrialscale deployment strategies.





CRM GROUP IN THE WORLD



Association for Iron & Steel Technology (AIST) 2024 Hunt-Kelly Outstanding Paper Award (AIME)

Third Place for the paper entitled "Importance of Roll Oxide to Increase Roll Life in a Hot Rolling Mill" – Authors: Sebastien Flament, Hugo Uijtdebroeks, Gisèle Walmag (CRM) and Zafer Koont (ArcelorMittal Global R&D - Hamilton)

2024 HELIOROOF, developed with CRM Group's expertise, wins the Smarter E AWARD HELIOROOF, an innovative **BIPV** solution for heat-insulating industrial steel roofs, received the 2024 Smarter E AWARD in the "Photovoltaics" category. This recognition highlights the collaboration between ArcelorMittal Construction and CRM Group in developing high-performance energy-efficient roofing systems.

The Global Performance Excellence Award 2024 for the ArcelorMittal project XCarb®RRP, a recognition of both ArcelorMittal's ambition and CRM Group's technical contribution. Since 2022, CRM Group is actively involved in ArcelorMittal's project on the industrialization of key XCarb® products, based on EAF steel with high scrap content and 100% renewable electricity, that was awarded in the Business Process Optimization category.

CONFERENCE & WORKSHOP PRESENTATIONS 2024

M. GREMLING

Design and model validation of MASH TL-5 steel median barrier

Transportation research board, AKD20(1) computational mechanics subcommittee, January 9th, 2024, Washington DC, USA

J. NEUTJENS

Workshop european clean steel: stand up together for a future low emission industry – Hydrogen: a powerful ally, January 25, 2024, Venice, Italy

N. NUTAL

Postprocessing of additively manufactured components with complex geometries

Worldwide advanced manufacturing symposium (WAMS) WAMS 2024 conference, February, Orlando, USA

N. JIMENEZ

Development of Al-Zn-Mg alloys for direct energy deposition and repair applications

Worldwide Advanced Manufacturing Symposium (WAMS) WAMS 2024 conference, February, Orlando, USA

N. JIMENEZ

Development of a new betametastable titanium alloy for additive manufacturing

Worldwide Advanced Manufacturing Symposium (WAMS) WAMS 2024 conference, February, Orlando, USA

M. LARNICOL, C. ARCHAMBEAU, X. VANDEN EYNDE

Chaîne de valeur de l'hydrogène vert : des initiatives d'innovation en Wallonie et des opportunités pour les entreprises VOM On Tour, February 9, 2024, Charleroi, Belgium

J. BORLÉE, R. CLOSE, V. DEVEEN, D. GAROT Capture de CO₂ en Wallonie : potentiel et enjeux Liège Creative Conference March 12, 2024, Liège, Belgium

P. ADRIAEN

SMARTCOOL: Smart controlled actuator to homogenize the temperature of the transfer bar

ESTEP Spring Dissemination event 2024, March 14, Brussels, Belgium

P. GUAINO

3D printed and additive electronic for steel industry and severe environment *ESTEP Spring Dissemination event 2024, March 14, Brussels, Belgium*

H. FOUARGE,

J.-C. PIERRET Upgraded ores and scrap processing to boost green steel production in existing steelmaking tools ESTEP Spring Dissemination event 2024, March 14, Brussels, Belgium

M. GREMLING

Alliance Réemploi poutrelles – ARP#3, requalifier une poutrelle

SWITCH – SPI Agence du Développement Territorial de la province de Liège, March 28th, 2024, Huy, Belgium

L. FOURDRINIER

Systemic Innovation: Drivers for a more Circular Economy in Belgium and Europe

Belgium Circular Economy Forum 2024, April 17, Brussels, Belgium

N. JIMENEZ

Alloy development for additive manufacturing

CRM Group's Members Day, April 17, 2024, Liège, Belgium

C. GEORGES

Manufacturing, repair, re-manufacturing CRM Group's Members Day, April 17, 2024, Liège, Belgium

CRM GROUP IN THE WORLD

D. FLORIN, A. DANIEL Surface finishing/functionalization of 3D-parts CRM Group's Members Day, April 17, 2024, Liège, Belaium

P. NYSSEN

Electrification of processes

CRM Group's Members Day, April 17, 2024, Liège, Belgium

D. GAROT, J. BORLEE, R. CLOSE, V. DEVEEN Process adaptation & CO., capture

CRM Group's Members Day, April 17, 2024, Liège, Belgium

M. LARNICOL

Hydrogen across its entire production & transport chain: interaction with metals and applications CRM Group's Members Day, April 17,

2024, Liège, Belgium

J.-C. PIERRET

Decarbonization of the steel industry -Implications for primary & secondary raw materials CRM Group's Members Day, April 17, 2024, Liège, Belgium

T. MARCON

Valorization of (new) steelmaking byproducts CRM Group's Members Day, April 17, 2024, Liège, Belgium

L. FRAIKIN

Critical Raw Materials from industrial residues and EOL products

CRM Group's Members Day, April 17, 2024, Liège, Belgium

N. NUTAL, F. NOVELLO Stress corrosion cracking testing of materials issued of additive manufacturing (LPBF & WAAM)

International conference on environmental systems Louisville 21-25/07/2024, EFC webinar online via Zoom, corrosion performance of additively manufactured metals, 21 May 2024

M. AIGNER, D. BEENTJES, H. BOLT, S. FLAMENT, A. PAAR, L. ELIZONDO A team effort to solve strip surface quality issues from hot rolling critical Applications AISTech 2024 conference, May 6, 2024 - May 9, 2024

D. EGNER, T. GOSSUIN, W. SMAILES Development of a new online sensor for steel surface contamination AISTech 2024 conference, May 6, 2024 - May 9, 2024

D. GAROT, G. RIVIÈRE

CO₂ mitigation in integrated plants by injection in the blast furnace of hot H₂-rich syngas produced from alternative carbon materials. RFCS PROSYNTEG Project

Steelmaster 2024 conference XXVI Edition, 6 May 2024 - 10 May 2024, Dalmine, Italy

D. EGNER, T. GOSSUIN, W. SMAILES Development of a new online sensor for steel surface contamination 2024 SEAISI Conference & Exhibition, 13 May 2024 - 16 May 2024, Ariyana Convention Centre, Danana, Vietnam

S. PACE, O. GILLET

Industrial coating developments by electron beam physical vapor deposition (EB-PVD) : technological challenges for the coating of steel strips at high speed

67th Annual SVC Technical Conference, 4-9 May 2024, Illinois, Chicago

J. NEUTJENS Circular economy of metals used in energy transition

CRM Group's inauguration plasma furnace, May 17th 2004, Engis, Belgium

C. GEORGES, N. JIMENEZ, M. JEAN-BAPTISTE, Yves DERRIENIC, R. EL DAKDOUKI, X. PITOISET Development of repair of large stainless steel parts by Direct Energy Deposition for the energy sector

19th European Mechanics of Materials Conference (EMMC), 29/05/2024-31/05/2024, Madrid, Spain

N. JIMENEZ, N. NUTAL

Characterization or repaired 7xxx aluminum components via Direct energy Deposition using newly developed Al-Zn-Mg alloys

19th European Mechanics of Materials Conference (EMMC), 29/05/2024-31/05/2024, Madrid, Spain

M. JEAN-BAPTISTE, C. GEORGES, S. PILITERRI, A. B. HJERMITSLEV Valorization of titanium Ti-6AI-4V scrap into high added value powders for manufacturing technologies

19th European Mechanics of Materials Conference (EMMC), 29/05/2024-31/05/2024, Madrid, Spain

J. BORLEE

Supporting the decarbonization of steel and heavy industries

Conference on industrial technologies INDTech 2024, June 3rd to June 5th, 2024, Namur, Belgium

X. VANDEN EYNDE

H₂ in steel industry
Workshop at Université Libre de
Bruxelles (ULB), June 14 2024, Belgium

J. NEUTJENS, A. RASSILI

Circular economy workshop

Princely trade mission, June 19th 2024, Oslo, Norway

M. GREMLING

Estimate of roadside safety hardware performance with finite element analysis

2nd international conference on roadside safety, June 25th, 2024, Orlando (FL), USA

M. ARSEENKO Printed heating elements on a 3D surface: direct writing vs. flexible substrate

International conference on nanotechnologies, organic electronics & nanomedicine (NANOTEXNOLOGY), from June 31st to July 5th, 202, Thessaloniki, Greece

R. PEYROU-LAUGA, N. NUTAL, J.-P. COLLETTE

Testing and qualification of phase change material heat capacitors

53rd International Conference on Environmental Systems ICES-2024-276 21-25 July 2024, Louisville, KY, USA

S. FLAMENT, G. WALMAG, H. BOLT M. GARGOURIMOTLAGH, P. HEISTERKAMP

Contact fatigue as dominant mechanisms for backup roll degradation in cold and temper rolling mills: on-site and laboratory investigations

7th international conference on abrasion wear resistant cast iron and forged steel for rolling and pulverizing mills: Abrasion 2024, 8-10 September 2024, Salzburg, Austria

S. FLAMENT, G. WALMAG, M. SINNAEVE

Influence of roll cooling water composition on surface degradation

7th international conference on abrasion wear resistant cast iron and forged steel for rolling and pulverizing Mills: Abrasion 2024, 8-10 September 2024, Salzburg, Austria

M. AIGNER, S. FLAMENT, M. PELLIZZARI, I. LAUBBICHLER, A. PAAR, M. REITER, T. TRICKL, N. KREMSMAIR, J. DOMITNER Impact of carbides on surface finish and wear characteristics of graphitic roll shell materials for hot rolling applications

7th International Conference On Abrasion Wear Resistant Cast Iron And Forged Steel For Rolling And Pulverizing Mills: Abrasion 2024, 8-10 September 2024, Salzburg, Austria

CRM GROUP IN THE WORLD

N. JIMENEZ

Development of new alloys for additive manufacturing: examples of aluminum alloy for DED process and titanium alloy for SLM process

Metal Additive manufacturing conference MAMC, Industrial Perspectives in Additive Technologies, 17-19 September 2024, Aachen, Germany

J.-F. VANHUMBEECK

Surface finishing of metal parts made by LPB-F process: application to complex aeronautical parts

Metal Additive manufacturing conference MAMC, Industrial Perspectives in Additive Technologies, 17-19 September 2024, Aachen, Germany

C. GEORGES

Repair of large industrial parts using robotized DED process

Metal Additive manufacturing conference MAMC, Industrial Perspectives in Additive Technologies, 17-19 September 2024, Aachen, Germany

K. SOFINOWSKI

Electrostatic Coating for High-Precision Blade Forging

A3TS/VOM Study Day: Surface Treatments in Aeronautics, September 19th, 2024, Molsheim, France

H. UIJTDEBROEKS

Enhancement of high-pressure water descaling and shot blasting

Reduction of heat losses during hot rolling of long products Seminar, VDEh-Betriebsforschungsinstitut GmbH, 24 September 2024

H. UIJTDEBROEKS

Roll cooling and lubrication system for a Universal Rolling Stand

Reduction of heat losses during hot rolling of long products Seminar, VDEh-Betriebsforschungsinstitut GmbH, 24 September 2024

M. GREMLING

Alliance Réemploi poutrelles – ARP#4, Positionnement de prix de la requalification

SWITCH – SPI Agence du Développement Territorial de la province de Liège, September 26th, 2024, Huy, Belgium

E. L. FARACI, M. GILI, D. RESSEGOTTI, D. GAROT, A. OBLANCA GUTIÉRREZ, C. MORELLI, L. MICHELETTI Production of hot hydrogen-rich syngas in integrated plants for efficient

injection in the blast furnace and CO₂ mitigation (ProSynteg)

European coke & ironmaking congress (ECIC), 16-18 October 2024, Bardolino, Italy

J.-C. PIERRET

Evolution in steel scrap recycling for a sustainable tomorrow

Flanders Metals Valley, Seminar on Scrap, October 23rd 2024, Brussels, Belgium

M. JEAN-BAPTISTE, S. PILLITTERI, C. GEORGES, A. B. HJERMITSLEV

Valorization of titanium Ti-6Al-4V scrap into high added value powders for manufacturing technologies ASTM International Conference on

Advanced Manufacturing (ICAM) October 28, 2024 - November 01, 2024, Atlanta, USA

C. GEORGES, N. JIMENEZ, Y. DERRIENIC, R. EL DAKDOUKI, X. PITOISET On the repair of steel parts with a

robotized directed energy deposition system for the nuclear industry

ASTM International Conference on Advanced Manufacturing (ICAM) October 28, 2024 - November 01, 2024, Atlanta, USA

P. SVAROVA, P. BILLY, T. KAIRET, R. GIAUX, S. GODET, L. MALET, B. KEBLER, D. DITTRICH, D. TIBERTO, A. HEMBERG L-PBF 3D Printing of AlZn5,5MgCu (7075) Aluminium modified with a TI-PVD coating : in-situ microalloying, printability and weldability assessment of the alloy

ECSSMET 2024, European Conference on Spacecraft Structures Materials and Environnemental Testing (ESTEC), 2024 September 23-27, Noordwijk, Netherlands

L. FOURDRINIER, B. VANDERHEYDEN, J. NEUTJENS

Walloon Initiative for Circular Materials day, October 11th, 2024, Liège, Belgium

H. UIJTDEBROEKS, J. MALBRANCKE Digitalization of the evaluation procedure of work roll degradation (ISYROLL)

ESTEP - Digital-4-Environment ESTEP workshop, 29-31 October 2024 voestalpine Stahl, Linz, Austria

F. VAN LOO

COACH - Cold-bonded agglomerates for blast furnace ironmaking with chemically engineered binders ESTEP annual event 2024, 29-31/10/2024, Linz, Austria

B. MIGNON, E. IPLIK

ZINCVAL – part 2 : Comparative pyrometallurgical treatment of zinc coming from low-zinc residues ESTEP annual event 2024, 29-31/10/2024, Linz, Austria

J. BORLÉE, G. RIVIÈRE, B. CABEZA, V. DEVEEN, D. GAROT, T. DE WITTE, B. RIEMS, W. VAN DER STRICHT, T. DEFEYTER, N. KIMPE The SMART project: Recycling of plastics and waste materials in TORERO to substitute more coal injection in the

blast furnace ESTEP workshop, Preparation and use of biogenic and non-biogenic secondary

biogenic and non-biogenic secondary carbon carriers (SCC) in processes for iron and steelmaking, SecCarb4Steel, Webinar, November 2024

H. FOUARGE

TACOS: Towards a zero CO₂ sintering

ESTEP workshop, Preparation and use of biogenic and non-biogenic secondary carbon carriers (SCC) in processes for iron and steelmaking, SecCarb4Steel, Webinar, November 2024

I. TOLLENEER

Sustainable Processes and Product Innovation at CRM

FMV meets UGent Metals Consortium, November 22, 2024, Ghent, Belgium

J. L. GARCÍA CIMADEVILLA, N. VEGA AGUIRRE, H. BOUCARD, M. KAPLAN, L. AHL, F. J. REAL SALAS, L. FRAIKIN, F. VAN LOO, B. MIGNON, P. IVASHECHKIN, F. GUERRERO, J.-B. WAUTERS ZHyRON project: valorization of iron-rich & zinc-containing steelmaking by-products via hydrogen-based reduction

Circular Metallurgy International Meeting, 28-29 November, Bergamo, Italy

C. PIERARD, M. KRID

Improving surface performance and rational management of pickling baths Café Techno organized by Aerospace Valley and Skywin November 7, 2024

B. VANDERHEYDEN

Preprocessing techniques at the service of circular economy – pilot scale applications in pyrometallurgy at CRM

11th PROMETIA Scientific Seminar – METNET session, 26-28 November 2024, Orléans, France

T. SENART, M. GAUCHEY A cost-effective Cold roll-forming FE model for industrial application NAFEMS Iberia, November 2024, Spain

M. MANDY, M. KRID Guide méthodologique pour l'interprétation des spectres de l'hydrogène obtenus par analyse de désorption thermique (TDA) A3TS conference, October 16-17, 2024, Courbevoie, France

CRM GROUP IN THE WORLD

PAPERS, PUBLICATIONS

D. MARNEFFE, C. PIERARD Étude de cas sur la ligne de décapage titane VOM Info, February 2024, number 01/2024

I. TOLLENEER

Recycler les déchets nucléaires, c'est possible Trends Tendance, Innovation Edition, March 2024

M. KRID

Understanding hydrogen desorption mechanisms in aluminized PHS (2024) UCLouvain PhD thesis

M. KRID, M. MANDY, T. STUREL

Impact of carbides on surface finish and wear characteristics of graphitic roll shell materials for hot rolling applications BHM Journal, November Journal 2024

S. FLAMENT, G. WALMAG, M. SINNAEVE Influence of roll cooling water composition on surface degradation BHM Journal, Abrasion Conference 2024, November Journal 2024

E. BEEVERS, N. JIMÉNEZ MENA, L. THIJS, N. NUTAL, A. NORMAN, B. VAN HOOREWEDER Development of a 7000 series aluminium alloy suitable for laserbased Additive Manufacturing Materials Science and Engineering A Volume 916, November 2024, 147334

K. SOFINOWSKI Revêtement électrostatique pour forgeage de haute précision des aubes (WINGS) VOM info 05/2024 E. MASARWEH, M. ARSEENKO, G. PHILIPPE, D. FLANDRE Membrane-based mechanical characterization of screen-printed inks: Deflection analysis of ink layers on polyimide membranes Applied research 3 (27) February 2024

F. D. DOMINICA, M. KARUPPASAMY, F. DAWANCE, J. BABER, H. FRIEDRICH, P. GUAINO

Printed electronics by plasma spraying: case study for high temperature sensors Journal of Thermal Spray Technology 33(117043), April 2024

J. DUPUY, A. MIAZEK, S. Boivinet, Y. HERNANDEZ, P. GUAINO, K. MUTHUKARUPPASAMY, M. ARSEENKO, D.BRUNEEL, C. PETIT Comparison of picosecond and femtosecond pulses in burst mode for realization of printed electronics circuits SPIE photonic europe, Vol 13005, 1300505 (2024)
M. SCHLAUTMANN, A. WOLFF, J.-C. PIERRET, O. ANSSEAU, V. ZAGREBIN, M. ILLICHMANN, O KÜSTER

Event-triggered model parameters adaption for long term reliability of process control along the electric steelmaking route Proceedings of AIM Conference, 11-13 September 2024, Napoli

N. NOTHOMB, I. RODRIGUEZ-BARBER, M. T. PÉREZ-PRADO, N. JIMENEZ MENA, G. PYKA, A. SIMAR Understanding the effect of pre-sintering scanning strategy on the relative density of Zr-modified Al7075 processed by laser powder bed fusion Additive Manufacturing Letters, Volume 11, December 2024

NOTES

LIFE AT CRM GROUP

BEYOND INNOVATION, A COMMUNITY SPIRIT

At CRM Group, innovation goes hand in hand with human values, collaboration, and long-term commitment. Beyond our technological achievements, 2024 was marked by numerous initiatives that fostered cohesion, well-being, and recognition within our teams.

Boosting creativity, innovation and collaboration

Since creativity and innovation are part of our values, 'midi-recreation' sessions are regularly offered to all our collaborators. To reinforce knowledge, technology watch and cross-fertilization, thematic workshops and brainstorm meetings are organized on topics such as sustainable development goals, Life Cycle Analysis and demonstration of our recent developments.

Yearly Objective Plan (YOP): a shared vision

Each year, CRM Group presents its strategic directions through the **Yearly Objective Plan (YOP)**. This pivotal moment ensures transparency and alignment, allowing everyone to understand the objectives, challenges, and opportunities that will shape the year ahead.

Commitment to equality: the gender equality plan

In 2024, CRM Group reaffirmed its commitment to diversity and inclusion through the implementation of its **Gender Equality Plan (GEP)**. This initiative structures our actions to promote gender balance, equal opportunities, and an inclusive work environment, in line with our societal values.

Honoring long-term commitment

We proudly celebrated 14 colleagues who reached significant career milestones this year, marking **25 or 35 years of service** within CRM Group. Their dedication, expertise, and unwavering commitment are key pillars of our organization's success. These anniversaries were an opportunity to express our gratitude and highlight the value of long-term engagement.



Team spirit and solidarity initiatives

Throughout 2024, CRM Group teams actively participated in various social and sporting events that reflect our values of solidarity and well-being:

 Participation in the 24h Vélo Télévie, supporting cancer research through a collective sporting challenge.





 Engagement in the ELA Charity Run, contributing to the fight against leukodystrophies.



The annual Staff Day, combining workshops on Sustainable Development Goals (SDGs), recreational activities, and an evening of celebration.

Welcoming new talents

Integration remains a priority, and in 2024, two **Newcomers' Days** were organized. These sessions allowed new employees to discover our various sites, meet teams, and immerse themselves in CRM Group's culture from their very first steps.

At CRM Group, "life at work" is built every day through initiatives that place people at the center of our strategy. Whether through moments of recognition, shared challenges, or commitments to societal values, we continue to cultivate an environment where collaboration, innovation, respect, and engagement drive both personal and collective success.

ORGANIZATION

LEADERSHIP TEAM



CEO: Chief Executive Officer / CPO: Chef Program Officer / CFO: Chief Financial Officer CSO: Chief Scientific Officer / CHRO: Chief Human Resource Officer / CTO: Chief Technical Officer



ON APRIL 16, 2025

Effective members

ARCELORMITTAL	G.D. Luxembourg
TATA STEEL Nederland .	The Netherlands

THE MAIN AFFILIATED COMPANIES ARE:

ARCELORMITTAL:	
ARCELORMITTAL BELGIUM	Belgium
ARCELORMITTAL CONSTRUCTION FRANCE	. France

ARCELORMITTAL FRANCE	France
ARCELORMITTAL LUXEMBOURG	G.D. Luxembourg
INDUSTEEL BELGIUM	Belgium
TATA STEEL:	

TATA STEEL IJMUIDEN	The Netherlands
TATA STEEL NEDERLAND TECHNOLOGY	The Netherlands

Associated Members

AGC Glass Europe	Belgium
AMEPA GmbH	Germany
APERAM Stainless France	France
AURUBIS OLEN	Belgium
BEBLUE CRYOTECH	Belgium
BEKAERT	Belgium
BIOCARBON INDUSTRIES	G.D. Luxembourg
COMET TRAITEMENTS	Belgium
DE LEUZE	Belgium
DREVER INTERNATIONAL	Belgium
DUFERCO	Switzerland
EMG Automation	Germany
EQUANS	Belgium
E.S.W.	Austria
FN Browning Group	Belgium
FONDERIES MARICHAL KETIN & Cie	Belgium
HEIDELBERG MATERIALS BENELUX	Belgium
HERAEUS ELECTRO-NITE INTERNATIONA	L Belgium
HYDROMETAL	Belgium
INDUCTOTHERM	Belgium
INSTITUT BELGE DE LA SOUDURE	Belgium
INTERNATIONAL MANGANESE INSTITUTE	E France

JOHN COCKERILL	Belgium
LABORELEC	Belgium
LHOIST Recherche & Développemen	t Belgium
MAGOTTEAUX INTERNATIONAL	Belgium
NLMK CLABECQ – Plates	Belgium
NLMK LA LOUVIÈRE – Strips	Belgium
ORBIX SOLUTIONS	Belgium
PAUL WURTH	G.D. Luxembourg
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CRM GROUP TAKES ACTIVELY PART TO THE FOLLOWING ORGANIZATIONS AND PLATFORMS

∕ . 6K	afelim	ASPIRE	BATTERY ALLIANCE BA250	EUROPEAN RAW MATERIAL ALLIANCE
GRE	HYBRID 3D		WIN 4C	REINDUSTRIALISER LA WALLONIE
MATERIALS RESEARCH	RIES	BSDI»		Wal-Tech
Asts	akt		ESTEP European Steel Technology Puttern	EUROFER
Hydrogen Europe Research	FLANDERS METALS VALLEY	G FULL RECO / US		Contesting master
e-WallonHY	PÔLE MECATECH	PROMETIA	Metallurgy	Skywin
TWSD	VI		worldsteel	

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CRM GROUP GRATEFULLY THANKS ITS INDUSTRIALS MEMBERS AND RESEARCH PARTNERS AS WELL AS THE FUNDING AUTHORITIES FOR THEIR COLLABORATION & SUPPORT



QUALITY MANAGEMENT



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Accreditation Certificate No. 267-TEST

In compliance with the provisions of the Royal Decree of 31 January 2006 setting up BELAC, the Accreditation Board hereby declares to have granted accreditation conform the requirements of the standard EN ISO/IEC 17025:2017 to:

CENTRE DE RECHERCHES METALLURGIQUES ASBL -CENTRUM VOOR RESEARCH IN DE METALLURGIE vzw C.R.M.

Rue Ravenstein 4

1000 Bruxelles

The body demonstrated the competence to perform the activities in the activity sites, as described in the scope of accreditation 267-TEST which is an integral part of the present certificate.

The current version of the scope of accreditation is available at www.belac.be.

This certificate remains valid as long as the body continues to meet the accreditation conditions.

The Chair of the Accreditation Board BELAC,



Maureen LOGGHE

Version ç 2023-03-16 - 2027-10-27 Validity period :

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The Chair of the Accreditation Board BELAC,

Maureen LOGGHE

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whose sites are established at, the CRM 45R, Centre de Recherches Mitallangques ASB1 - trenue du Burs Saint-Jean 21 - 827 - Quartier Polytech 4 - 4941 Angleue - Belgium, Hile de Hunnweiturs 1 - 857 - Quartier Polytech 4 - 4001 Leige - Religium, Bae du Bars Saint-Jean A. 4192 Ougree - Religium, Bae du Polies 1 - 856 - Quartier Polytech 2 - 4000 Leige - 800 at Leige - 8000 Leige - Religium, Each Mite 46 - 957 Zugenanade-Religium, Bae du Chéra 260 - 4000 Leige - Religium, Bae du Polies 1 - 4400 Erige - Religium. Religium, Bae du Pont Polytech 1 - 4400 Erige - Religium.

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Industrial research and associated artivities such as testing, calibration and expertise.

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