RESEARCH NEWS

Fraunhofer at the HANNOVER MESSE 2025

ORCHESTER: Digital Ecosystem Decreases Use of Raw Materials in Production

As part of a Fraunhofer flagship project, researchers are developing a digital ecosystem that collects data along the entire value chain for raw materials — with the goal of ensuring a sustainable and resilient supply. This makes it possible to reuse and recycle materials energy-efficiently and with as little loss as possible. At the HANNOVER MESSE 2025, the research team will be presenting a demonstrator that showcases the many different options offered by this ecosystem.

Knowledge about raw material cycles is a crucial factor when companies set out to make their production activities more sustainable and resilient. With this in mind, six Fraunhofer institutes have joined forces in Fraunhofer's ORCHESTER flagship project. They are developing a digital ecosystem for industry that aggregates all the data arising along the value chain — from production of raw materials to delivery and processing of materials, manufacturing of the finished product and beyond to disposal and recycling. This data is combined with further information from production, such as the results of material testing or sensor data, and incorporated into a single platform.

The interaction of information and data from diverse sources makes the raw material cycles transparent. And that allows companies to manage their supply of metals such as rare earths more effectively on a day-to-day basis and respond to fluctuations in the supply chain early on. At the same time, they can harness the data to conserve resources, reduce CO2 emissions and make production and use of raw materials socially sustainable.

Less use of rare earths, more of recycled metal

Dirk Helm from the Fraunhofer Institute for Mechanics of Materials IWM cites three of the project's concrete goals in the area of production: "We aim to increase the percentage of recycled materials used by at least 50 percent, lower the percentage of rare earths by at least 25 percent, and quintuple the selection of materials suitable for production on the whole."

The Fraunhofer researchers will show how the digital ecosystem developed in the project works in practice with a demonstrator focusing on recycling powerful permanent magnets made of neodymium, a metal with a silvery sheen that belongs to the group of elements known as rare earths. These kinds of magnets are used in applications such

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as electric motors and wind turbines. The researchers are working to significantly reduce the amount of neodymium used in production by adding secondary raw materials such as scrap metal magnets.

MagnetPredictor tool calculates mixture

To calculate the mixture ratios needed for this, the Fraunhofer researchers have developed a simulation tool called MagnetPredictor. Users can enter the concentrations of foreign elements in the graphical user interface to determine quality features or properties of the product. This includes the maximum magnetizability (saturation magnetization) of the material and the field (anisotropy field) necessary to overcome its preferred magnetization direction. "This information can be used to determine how high the level of contaminated magnetic scrap can be to arrive at the desired result without impacting the quality of the finished product. Aspects like cost and environmental footprint are also factored into the tool's calculations," Helm explains.

In another project step, the Fraunhofer Research Institution for Materials Recycling and Resource Strategies IWKS produces the magnets using the calculated mixture of recycled metal and, where applicable, primary raw materials such as neodymium. To do this, the magnetic scrap is presorted, then mixed with neodymium and other raw materials and melted down. This produces metal "flakes" that are then embrittled with hydrogen. The coarse-grained powder left after that is then ground down and pressed into a mold. During the molding process, a magnetic field ensures that all the grains line up along a single axis. Following heat treatment in a furnace and final magnetization, the magnet is finished.

Demonstrators at the HANNOVER MESSE 2025

The ORCHESTER flagship project is developing three demonstrators in all. Aside from MagnetPredictor, another demonstrator helps with production of bipolar plates for electrolyzers and fuel cells or heat exchangers with the goal of lowering the amount of nickel — a critical element that carries hefty risks associated with supply — used in them and reducing the costs of production. The third demonstrator serves to increase the amount of secondary raw materials used in aluminum alloys in components for hydrogen pipelines, fuel cells and heat pumps, thereby minimizing their energy footprint.

The Fraunhofer researchers will be presenting the entire digital ecosystem and all three demonstrators at the large joint booth operated by the Fraunhofer-Gesellschaft (Hall 2, Booth B24) at the HANNOVER MESSE (March 31–April 4, 2025).

ORCHESTER flagship project

Objective: Digital ecosystem for resilient, sustainable supply of functionally reliable materials
Term: January 2024–December 2027

Project partners:
• Fraunhofer Institute for Mechanics of Materials IWM (lead entity in the consortium)
Assessing the safety and reliability of materials and components

• Fraunhofer Institute for Systems and Innovation Research ISI
Researching innovation processes and their social impacts

• Fraunhofer Research Institution for Materials Recycling and Resource Strategies IWKS
Expertise in holistic approaches to close material loops

• Fraunhofer Institute for Material and Beam Technology IWS
System solutions in laser, surface and materials technology. Additive manufacturing as a screening method for sustainable material design

• Fraunhofer Institute for Nondestructive Testing IZFP
Intelligent sensor and data systems for analysis of materials and processes

• Fraunhofer Institute for Machine Tools and Forming Technology IWU
Production technology for green products in flexible material flows

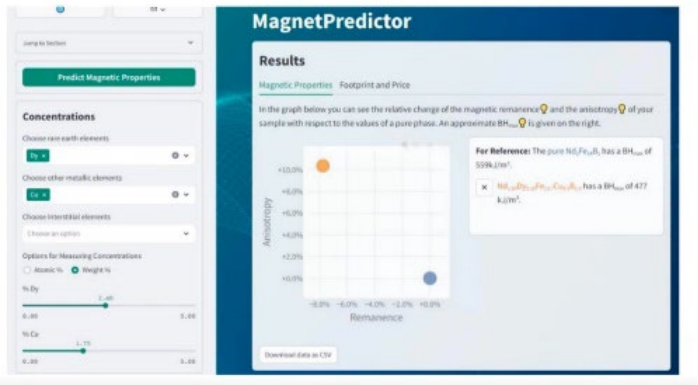

Fig. 1: MagnetPredictor: After the alloys and concentrations are entered, the simulation tool calculates the magnetic properties. This makes it possible to estimate how high the level of secondary raw materials can be in order to achieve the desired material properties.

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Fig. 2: Magnet production: The magnets contain a mixture of neodymium as a primary raw material and recycled magnets or magnetic scrap. This makes it possible to reduce use of valuable raw materials.

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