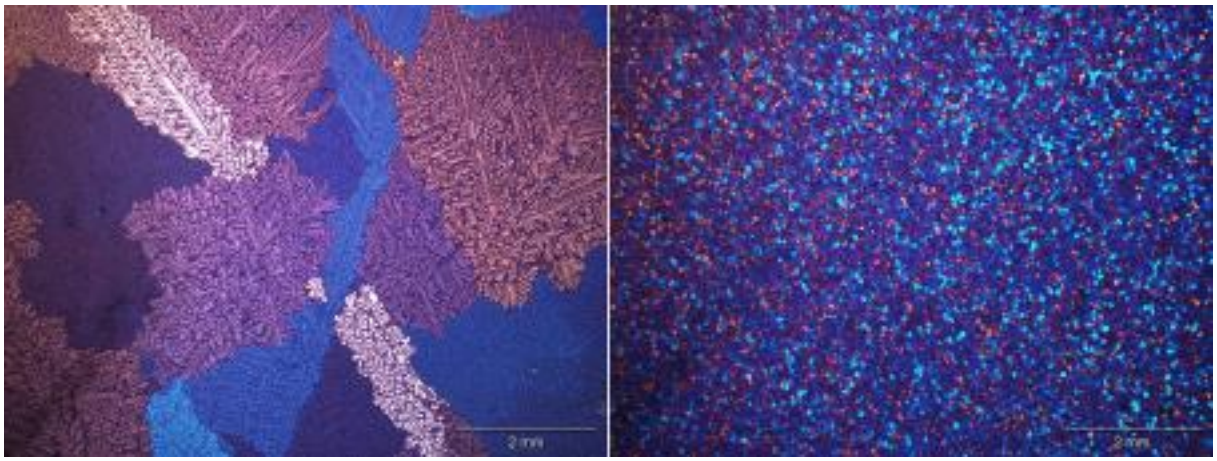
Magnesium materials: Enabling forming with nanoparticles

About this project



OptUm-MagNa

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Markets:

Material: Magnesium, Others (AM60 magnesium alloy (Mg-6Al) | nanocomposite AM60-xCa-yAlN), Nanocomposites, Particulate composites

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Technology Transfer Program Leichtbau

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Context

Magnesium has the lowest density of all metallic construction materials and therefore has great potential for lightweight construction. Its modulus of elasticity, i.e. the ratio of stiffness to weight, is significantly higher than that of other lightweight metals such as aluminium. This makes magnesium particularly suitable for applications in the automotive and aerospace industries, where every kilogramme of weight counts.

Nevertheless, its use has so far been limited: Conventional magnesium alloys can hardly be formed, as their hexagonal lattice structure only allows low ductility - i.e. plastic deformability. Formable variants have not yet achieved the required strength and have poor processing properties. This prevents manufacturers from using magnesium in load-bearing lightweight components. The researchers in the OptUm-MagNa project want to change this.

Purpose

The project team wants to qualify magnesium alloys for forming technology - i.e. not just casting, but also forging or extruding (extrusion). The researchers are using so-called nanocomposites for this purpose: They add ceramic nanoparticles in the size range below 100 nanometres to the magnesium. These particles cause extreme grain refinement in the structure of the metal. This increases strength, improves ductility and significantly increases formability.

The result is a material that for the first time offers a combination of low weight, high strength and good formability. In addition, flammability is reduced - an important aspect especially for aviation. Instead of using expensive and critical rare earths, the scientists use calcium or calcium oxide as an alloy additive to reduce the fire behaviour to the level of molten aluminium.

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Procedure

Firstly, the researchers investigate the optimum composition of the nanocomposite. They vary the particle size and concentration and analyse their influence on the microstructure and mechanical properties. The moulded semi-finished product is then forged, extruded or extruded in the laboratory. In microstructure analyses during the forming process, the team determines the relationships between forming parameters, grain structure and component properties. The aim is to specifically adjust the material properties via the forming conditions.

At the same time, the researchers are developing processes to enable the material to be processed under real industrial conditions - in an energy-efficient and resource-saving manner. Finally, they are comparing prototype components made from the new magnesium nanocomposite with conventional aluminium parts. The focus here is on weight, rigidity, strength and flammability. Finally, an economic assessment will show the potential for industrial applications - including beyond mobility, for example in medical technology.

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Funding duration:

Funding sign: 03LB2040 **Funding amount:** EUR 747 thousand

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Project coordination

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Leuphana Universität Lüneburg, Institut für Produkt- und Prozessinnovation (PPI)

Lightweighting classification

	Realisation
Offer	
Products Parts and components, Semi-finished parts, Materials, Tools and moulds, Others (Raw material for forging process)	✓
Services & consulting Training, Prototyping, Validation, Simulation, Technology transfer	✓

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Lightweighting classification

	Realisation
Field of technology	
Design & layout Lightweight material construction	✓
Functional integration	
Measuring and testing technology Materials analysis	✓
Modelling and simulation Processes, Others (Simulation of the forming of magnesium nanocomposites)	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming Impact extrusion, Forging, Extrusion moulding	✓
Joining	
Material property alteration Others (Addition of AlN nanoparticles, which are introduced into an AM60 melt with the aid of ultrasound-assisted bag casting, leads to significant grain refinement)	✓
Primary forming Others (High-shearing process | ultrasonic-assisted casting | discontinuous continuous casting or belt casting)	✓
Processing and separating Sawing, Others (Deburring / pickling)	✓
Textile technology	

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Lightweighting classification

Material	Realisation
Biogenic materials	
Cellular materials (foam materials)	
Composites Nanocomposites, Particulate composites	✓
Fibres	
Functional materials	
Metals Magnesium, Others (AM60 magnesium alloy (Mg-6Al) | nanocomposite AM60-xCa-yAlN)	✓
Plastics	
Structural ceramics	
(Technical) textiles	