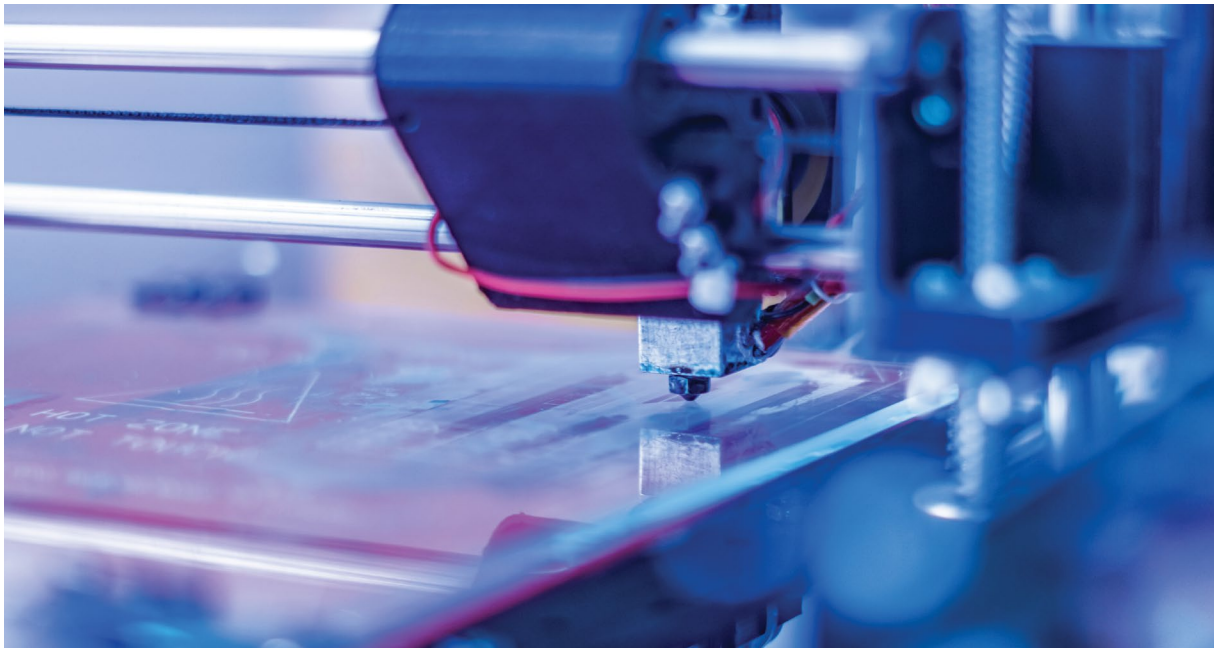
Glass-fibre-containing materials could find new life in orthopaedic assistive devices

Innovative processing, nanotechnology and additive manufacturing come together to enable recycling and reuse of carbon fibre-reinforced polymer composites.



The fibre-reinforced polymer industry has its roots in the development of fibreglass, a composite of glass fibres embedded in a polyester resin matrix, nearly a century ago. In 1958, the first high performance carbon 'whiskers' were produced, paving the way for the use of very high-strength carbon fibres in low-weight carbon fibre reinforced polymers (CFRPs). CFRPs are now widely used in virtually every industry, including transport, aerospace, construction, electronics and biomedicine.

Their combination of strength and low weight has led to more sustainable transport with fewer emissions. Improving recycling and reuse of CFRPs will contribute to a circular economy of this huge global market with a large carbon footprint. The EU-funded Repair3D project has contributed towards addressing this need. Its advanced nanotechnology solutions and additive manufacturing (AM) processes will enable the production of high added-value 3D-printed products with advanced functionalities from recycled resources, pushing the boundaries of sustainable production.

CFRP recycling: challenges and opportunities

Composites like CFRPs are difficult to recycle due to their heterogeneous structure and composition. Current recycling methods often use harsh chemicals that destroy the matrix resin materials and leave carbon fibres damaged in the process. Additionaly the cost of recycling is high making the commercial incentive low.

The CFRPs market offers significant growth potential beyond conventional transport and construction sectors. Lowering the cost of CFRPs' use through economical, local recycling and the integration of nanotechnology-based smart sensing and self-healing properties to extend lifespan could spur tremendous innovation by smaller players such as SMEs. Repair3D has worked towards tackling this challenge.

To date, the project has designed five industrial demonstrators and successfully produced a vase, personalised orthopaedic assistive devices, the shell (solid outer layer) of a ski boot and automotive parts.

Characterising reclaimed CFRP carbon filaments

Repair3D evaluated the properties and processability of reclaimed carbon filaments during multiple recycling cycles. "Despite the thermomechanical degradation that polymers undergo through melting and re-extrusion, recycled carbon filaments seem to meet 3D printing requirements throughout a number of recycling processes; adding some virgin material improves the mechanical properties and enhances the viscosity for printing" states the project coordinator Isella Vicini of Warrant Hub. In addition, toxicity assessments showed that the recycled materials are suitable for medical applications.

Industrial applications and product demonstrators

Having achieved the successful reclaiming and 3D printing of carbon filaments from CFRPs, the team moved to design a sustainable product. The Repair3D consortium applied principles of design for AM, design for recycling and safety by design (particularly for the nanomaterials used to support the smart sensing and self-healing properties). The production and testing of the demonstrators employed innovative tools produced by the partners.

"The materials developed from recycled CFRPs have been mechanically characterised, confirming suitable performance for use in many industrial applications. To date, the project has designed five industrial demonstrators and successfully produced a vase, personalised orthopaedic assistive devices, the shell (solid outer layer) of a ski boot and automotive parts," notes Vicini. Supporting the EU's digital and green transition, as well as smart sensing and self-healing, the consortium has developed an Internet of Things strategy, creating radio-frequency identification tags for each demonstrator.

Repair3D has delivered nanotechnologies and AM processes that will enable CFRP reclamation and reuse in innovative high-added-value products with advanced smart sensing and self-healing properties. This should create new business opportunities while reducing landfill waste and the carbon footprint of novel products in a variety of applications.

PROJECT
Repair3D - Recycling and Repurposing of Plastic Waste for Advanced 3D Printing Applications

COORDINATED BY
Warrant Hub Spa, Italy

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CORDIS FACTSHEET
cordis.europa.eu/project/id/814588

PROJECT WEBSITE
repair3d.net/