

DESIGN AND TECHNOLOGY. PEOPLE, ENVIRONMENT, SYSTEMS

DAD - Design Methods to Accelerate Material Technologies Toward Industry

Funded By	Dipartimento DAD
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Context of the research activity	<p>Within the thematic area “Technological and materials culture”, the research activities of a multi- and transdisciplinary group of scholars are outlined, focusing on innovative materials for design, architecture, and environmental comfort. Their research settings include, among others, the Department’s material libraries, while the main accelerators of their work are not only collaborations with industry but also competitive funding, which acts as a true boost for innovation in this field.</p> <p>This has led to projects aimed at developing new materials that better meet the constantly evolving demands of the market, capable of addressing unexpressed needs, anticipating future trends and supply chains, valorising production waste, mitigating issues of raw material overabundance, and extending product lifespans through the strategic selection of materials —among many other objectives.</p>
	<p>The world of materials is in constant evolution, and increasingly, innovative material concepts emerge within universities and research centres that, however, lack the strength and momentum needed to reach market introduction. This prevents their potential from being realized and undermines the effort invested in fundamental research.</p> <p>This doctoral research focuses on a more advanced TRL phase (6–9), aiming to strengthen—through methodologies, tools, and capabilities typical of Design, Technological Innovation, and other disciplines—the stages of experimental development, industrialization, and marketing that are necessary to bring high-potential yet low-industry-subsidized material innovations to market.</p> <p>The thesis will include a direct research application within the European project BIOMAPS (HE, 2025–28), dedicated to developing and demonstrating the feasibility of large-scale production of new bio-based, bio-inspired biopolymers. These materials belong to the broader class of biopolymers but exhibit hybrid characteristics between thermoplastic and thermosetting</p>

Objectives

polymers.

In this project, which involves 11 European partners including universities, research centres, and companies, the focus is on addressing the manufacturability—and thus the availability—of bioplastics through biosynthetic production and the systematic integration of digital tools and modelling across all production stages.

The research will concentrate on PHAs, a family of biodegradable polymers with excellent and versatile material properties, whose manufacturability is enhanced through the introduction of new functionalities and improved processability via vitrimerization—a process enabling unprecedented control over the material's viscoelastic properties, allowing mechanical recycling and reuse of polymers that would otherwise be non-recyclable, with minimal loss of mechanical performance—thus producing Covalent Adaptive Networks (CANs).

These solutions help mitigate pollution caused by microplastics, which today represents a global challenge. Microplastics persist in the environment and alter ecosystems by accumulating in water, soil, and air, even entering the food chain through various living organisms. Biodegradable plastics of biological origin, such as polyhydroxyalkanoates (PHAs), avoid this issue. However, their current use is hindered by difficulties in production and processing (including recycling), limited availability leading to high costs, lower mechanical properties, and the lack of added value compared to petrochemical-based counterparts.

This research therefore engages with some of the most current themes of sustainability—primarily environmental, but not exclusively—as well as the functional, relational, and perceptual requirements related to the changing socio-economic and technological—production contexts surrounding new materials.

Skills and competencies for the development of the activity

- Aptitude for research and strong interest in pursuing a doctoral path;
- Curiosity for the world of innovative materials and technological developments in the field of material-driven innovation;
- Preferably, experience in conducting participatory design research, both within and beyond academia;
- Preferable knowledge of the landscape of Italian material libraries (materioteche);
- Good academic writing skills (scientific papers, reports, theses, etc.);
- Strong interest in the role of design in community engagement and social innovation;
- Ability to work collaboratively within a complex and international research framework;
- Excellent command of spoken and written English.