MECHANICAL ENGINEERING

DIMEAS - Green metals for structural applications in the automotive sector

Funded By	Dipartimento DIMEAS
Supervisor	PAOLINO DAVIDE SALVATORE - davide.paolino@polito.it
Contact	BOURSIER NIUTTA CARLO - carlo.boursier@polito.it TRIDELLO ANDREA - andrea.tridello@polito.it
Context of the research activity	The research focuses on innovative, high-performance metallic materials derived from recycled sources for structural automotive applications. It aims to reduce environmental impact by promoting fully recyclable metals with low-carbon processing, supported by experimental characterization and predictive modelling, aligning with EU goals for climate neutrality and circular economy in the transport sector.
	Every year, approximately 8 million tons of non-recyclable waste resulting from the end-of-life of transport vehicles are produced within the European Union. This alarming amount of waste highlights a critical environmental challenge that demands urgent and innovative solutions, particularly in the automotive sector. The issue is further exacerbated by increasingly strict European regulations, which aim to reduce pollutant emissions and promote sustainability across the entire life cycle of vehicles, from production to disposal. To address these regulatory and environmental pressures, the automotive industry is increasingly adopting lightweight materials, with a focus on reducing vehicle weight to enhance fuel efficiency and decrease CO2 emissions during the operational phase. This trend supports the growing shift toward hybrid and electric mobility, where lightweighting is essential to extend driving range and optimize performance. However, reducing vehicle mass alone is not sufficient to meet the broader environmental objectives, especially those concerning the final stages of a vehicle's life cycle. Traditional materials, even when lightweight, often pose significant challenges in terms of recyclability, energy-intensive production, or environmental impact at disposal. As a result, there is a growing interest in integrating innovative metallic materials that are not only high-performing in terms of mechanical and physical properties but also fully recyclable and environmentally sustainable. In this context, green metallic materials are emerging as promising candidates. These materials can be recycled multiple times without substantial degradation of their mechanical properties, contributing to a circular economy model. Furthermore, their use can significantly reduce the

Objectives	carbon footprint associated with the production phase, especially when sourced from recycled streams using low-energy refining processes. Despite their potential, the widespread adoption of these innovative green metals in structural automotive applications still faces several challenges. These include limited data on long-term mechanical performance and the need for reliable predictive tools to support their integration into design processes. The main goal of this research activity is to consolidate knowledge and expertise in the field of high-performance, recyclable metallic materials for structural applications in the automotive industry. The research aims to support a sustainable transition by enabling the use of advanced green metals without compromising on performance, safety, or regulatory compliance. To this end, the activity will focus on the following areas: • The development of robust experimental methodologies to accurately characterize the mechanical behavior, durability, and recyclability of green metallic materials under various operational conditions typical of automotive use. • The creation and validation of analytical and numerical models capable of simulating the mechanical response of automotive components made from recycled metals, thus enabling their optimized design and broader industrial adoption. This research aligns with European priorities on climate neutrality, resource efficiency, and sustainable mobility. By promoting the use of recycled, high-performance metals in automotive manufacturing, the project contributes to reducing industrial emissions, lowering dependency on primary raw materials, and supporting the implementation of circular economy principles within a key industrial sector.

Skills and competencies for the development of the activity	Mechanical characterization and numerical modeling of metallic materials for structural applications. Innovative metallic materials for structural applications: characterization and manufacturing.