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Title	Innovative Additive Manufacturing Chains for Automotive Gears
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Abstract

The Industry 4.0 and the transformations of the automotive industry towards electromobility should impose new demands to the Gear Industry in terms of materials, design, manufacturing and supply chain. Additive manufacturing is one of the technologies of industry 4.0 that should enable solutions in this sense and has attracted investments of the automotive industry worldwide. Design freedom, material combinations and decentralized manufacturing are some of the benefits associated to the technology. Metal additive manufacturing processes have then been developed in order to provide adequate mechanical properties and productivity for high performance and mass production applications. The first steps on the development of additive manufacturing chains with carburizing steels for gears production in a national cooperation are presented. The potential, methods and challenges associated to materials, surface integrity, gear design and metal-polymer combinations are covered. It is shown that carburizing steels processed by direct Laser Powder Bed Fusion present different metallurgical features in comparison to traditional processing, which is an opportunity for the expansion of materials science knowledge. Complex process parameters to be optimized and heterogeneous surface integrity were some of the challenges addressed. Superior mechanical properties were obtained through L-PBF in comparison to the conventional steel, however other effects were associated to the process, such as anisotropy and porosity. The findings also indicated that gear additive manufacturing requires new processing chain considerations for surface integrity enhancement. Different design opportunities and topology optimization methods were employed and about 30% of mass reduction was obtained for the selected gear. The geometrical complexity additionally allowed a metal-polymer combination, which resulted in expressive reduction of noise and vibration effects in preliminary excitation tests. Finally, the additive manufacturing is considered a promising disruptive technology for gear applications and further developments should increase its maturity for industrial adoption.