The role of substrate surface finishing in determining the tribological properties of DLC coatings on additive manufactured AlSi10Mg components

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Selective Laser Melting (SLM) has been introduced in the automotive and aerospace industry as an Additive Manufacturing (AM) technique for the fabrication of metallic components. AM materials are generally affected by defects and poor surface finishing, and surface preparation is mandatory before the deposition of functional coatings. In this work, we studied the tribological performances of diamondlike carbon (DLC) coating on SLM-produced AlSi10Mg substrates. Hydrogen-free DLC was deposited by magnetron sputtering with the interposition of a Cr/CrN layer, resulting in a total film thickness of 1.7 µm. Substrates were prepared with different finishing procedures in order to explore the influence of the surface roughness on the coating behaviour. A root mean square surface roughness (Sq) ranging from 300 nm to 2.7 µm was obtained for the coated surfaces. Ball-on-disc experiments were performed with a 100Cr6 counterpart and loads in the 1-10 N range. Thought the DLC films exhibit similar hardness and composition, as revealed by Raman and nanoindentation analyses, significant variation of the friction coefficient (CoF) as a function of roughness was observed. Higher CoFs are associated to the smoothest and the roughest samples, possibly caused by a strong contribution of adhesion and abrasion, respectively, and intermediate Sq values minimize friction. Delamination occurred in some cases when rising the load to 10 N; FIB cross-sections suggested that this is ascribable to the failure of the AlSi10Mg substrate rather than to coating abrasion. Such results corroborate the effectiveness of DLC coatings in improving the tribological properties of AM parts, and indicate that smoother surfaces do not necessarily imply better performances. The present work was supported by the RIMMEL project PG/2018/631311, POR FESR EMILIA ROMAGNA 2014-2020, Asse 1 - Ricerca e Innovazione. The authors acknowledge the company BEAMIT S.p.A. for providing the additive manufactured samples.