Tribological Behaviour of the Degradation Process of Additive Manufactured Stainless Steel 316L

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Abstract : Additive manufacturing (AM) possesses several key characteristics, including high design freedom, energy-efficient manufacturing process, reduced material waste, high resolution of finished products, and excellent performance of finished products. These advantages have garnered widespread attention and fueled rapid development in recent decades. AM has significantly broadened the spectrum of available materials in the manufacturing industry and is gradually replacing some traditionally manufactured parts. Similar to components produced via traditional methods, products manufactured through AM are susceptible to degradation caused by wear during their service life. Given the prevalence of 316L stainless steel (SS) parts and the limited research on the tribological behavior of 316L SS samples or products fabricated using AM technology, this study aims to investigate the degradation process and wear mechanisms of 316L SS disks fabricated using AM technology. The wear mechanisms and tribological performance of these AM-manufactured samples are compared with commercial 316L SS samples made using conventional methods. Additionally, methods to enhance the tribological performance of additive-manufactured SS samples are explored. Four disk samples with a diameter of 75 mm and a thickness of 10 mm are prepared. Two of them (Group A) are prepared from a purchased SS bar using a milling method. The other two disks (Group B), with the same dimensions, are made of Gas Atomized 316L Stainless Steel (size range: 15-45 µm) purchased from Carpenter Additive and produced using Laser Powder Bed Fusion (LPBF). Pin-on-disk tests are conducted on these disks, which have similar surface roughness and hardness levels. Multiple tests are carried out under various operating conditions, including varying loads and/or speeds, and the friction coefficients are measured during these tests. In addition, the evolution of the surface degradation processes is monitored by creating moulds of the wear tracks and quantitatively analyzing the surface morphologies of the mould images. This analysis involves quantifying the depth and width of the wear tracks and analyzing the wear debris generated during the wear processes. The wear mechanisms and wear performance of these two groups of SS samples are compared. The effects of load and speed on the friction coefficient and wear rate are investigated. The ultimate goal is to gain a better understanding of the surface degradation of additive-manufactured SS samples. This knowledge is crucial for enhancing their anti-wear performance and extending their service life.

Keywords : degradation process, additive manufacturing, stainless steel, surface features
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