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Investigation of Mechanical and Tribological Property of Graphene Reinforced SS-316L Matrix Composite Prepared by Selective Laser Melting

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Abstract : A fundamental investigation is performed on the development of graphene (Gr) reinforced stainless steel 316L (SS 316L) metal matrix composite via selective laser melting (SLM) in order to improve specific strength and wear resistance property of SS 316L. Firstly, SS 316L powder and graphene were mixed in a fixed ratio using low energy planetary ball milling. The milled powder is then subjected to the SLM process to fabricate composite samples at a laser power of 320 W and exposure time of 100 µs. The prepared composite was mechanically tested (hardness and tensile test) at ambient temperature, and obtained results indicate that the properties of the composite increased significantly with the addition of 0.2 wt. % Gr. Increment of about 25% (from 194 to 242 HV) and 70% (from 502 to 850 MPa) is obtained in hardness and yield strength of composite, respectively. Raman mapping and XRD were performed to see the distribution of Gr in the matrix and its effect on the formation of carbide, respectively. Results of Raman mapping show the uniform distribution of graphene inside the matrix. Electron back scatter diffraction (EBSD) map of the prepared composite was analyzed under FESEM in order to understand the microstructure and grain orientation. Due to thermal gradient, elongated grains were observed along the building direction, and grains get finer with the addition of Gr. Most of the mechanical components are subjected to several types of wear conditions. Therefore, it is very necessary to improve the wear property of the component, and hence apart from strength and hardness, a tribological property of composite was also measured under dry sliding condition. Solid lubrication property of Gr plays an important role during the sliding process due to which the wear rate of composite reduces up to 58%. Also, the surface roughness of worn surface reduces up to 70% as measured by 3D surface profilometry. Finally, it can be concluded that SLM is an efficient method of fabricating cutting edge metal matrix nano-composite having Gr like reinforcement, which was very difficult to fabricate through conventional manufacturing techniques. Prepared composite has superior mechanical and tribological properties and can be used for a wide variety of engineering applications. However, due to the unavailability of a considerable amount of literature in a similar domain, more experimental works need to perform, such as thermal property analysis, and is a part of ongoing study.

Keywords : selective laser melting, graphene, composite, mechanical property, tribological property
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