Abstract

The fabrication of mechanical components depends upon the applications, which call for different materials with different properties. Apart from this, the failure of lubricant properties at elevated temperatures has resulted in the proper selection of materials for various tribological applications. The cost of procurement of these materials and machining them into tools and components is also arduous. Therefore, in tribological contacts at elevated temperatures, it is imperative to select coatings as an alternative for increasing the life of these tools and machinery components.

The design and selection criteria of the coatings are based on different tribological applications. The present study was focused on the tribological responses of multilayer and nanocomposite coatings at elevated temperatures. The multilayer coatings were sputter deposited, while the nanocomposite coatings were polymer-based coatings deposited through spray pyrolysis. The incorporation of the ductile layer between the hard ceramic layers in the multilayer coating not only reduces the internal stress of the coating but also prevents the propagation of cracks from one brittle layer to another. The polymer nanocomposite coatings were prepared by reinforcing them with pristine and alkylated MoS_2 nanosheets to enhance their tribological properties.

The various machine tools and equipment made of SS 304 suffer severe damage from galling while working. Therefore, new coatings are developed to prevent surface damage to avoid galling at room and elevated temperatures. The Mo/DLC coatings were developed to prevent the galling at room and elevated temperatures (around 300˚C). All galling tests were conducted on the test rig made in accordance with ASTM G196. The DLC (diamond like carbon) has a mixture of sp^2 and sp^3 hybridized carbon. The deposition of the DLC layer through high power impulse magnetron sputtering (HiPIMS) ensured a high deposition percentage of sp^3

hybridized carbon. The soft Mo layer deposited through a pulsed DC power source helped reduce the internal stress and helped in depositing coating with higher thickness. Almost a three-fold increase in the load-bearing capacity was observed in the tribopair, having coated against uncoated samples. A cost-effective way of increasing the galling resistance of SS 304 has also been explored by coating the samples with polyurethane (PU) based nanocomposite coatings. The PU based coatings were reinforced with pristine and alkylated MoS_2 nanosheets to improve their tribological performance. A comparative study has been presented on the reciprocating and galling wear performance of the PU based nanocomposite coatings. The surface of the pristine MoS_2 nanosheets was modified with octadecane thiol (ODT) to form alkylated MoS_2 nanosheets. The PU-MoS_2-ODT coatings showed significant decrease in friction and wear, 77 and 95%, respectively. Furthermore, the galling resistance of PU-MoS_2-ODT coating was better than the plain PU and PU-MoS_2 coatings.

Various characterization techniques were employed to study the properties of the coatings and the worn scar. These include field emission scanning electron microscopy (FESEM), elemental dispersive x-ray analysis (EDAX), Raman spectroscopy, x-ray photoelectron spectroscopy (XPS), nanoindentation, Fourier transform infrared spectroscopy (FTIR), stereo-zoom optical microscopy, and nanosctratch testing.