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Studies on the Characterization and Machinability of Duplex Stainless Steel 2205 during Dry Turning

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Abstract : The present investigation is a study of the effect of advanced Physical Vapor Deposition (PVD) coatings on cutting temperature residual stresses and surface roughness during Duplex Stainless Steel (DSS) 2205 turning. Austenite stabilizers like nickel, manganese, and molybdenum reduced the cost of DSS. Surface Integrity (SI) plays an important role in determining corrosion resistance and fatigue life. Resistance to various types of corrosion makes DSS suitable for applications with critical environments like Heat exchangers, Desalination plants, Seawater pipes and Marine components. However, lower thermal conductivity, poor chip control and non-uniform tool wear make DSS very difficult to machine. Cemented carbide tools (M grade) were used to turn DSS in a dry environment. AlTiN and AlTiCrN coatings were deposited using advanced PVD High Pulse Impulse Magnetron Sputtering (HiPIMS) technique. Experiments were conducted with cutting speed of 100 m/min, 140 m/min and 180 m/min. A constant feed and depth of cut of 0.18 mm/rev and 0.8 mm were used, respectively. AlTiCrN coated tools followed by AlTiN coated tools outperformed uncoated tools due to properties like lower thermal conductivity, higher adhesion strength and hardness. Residual stresses were found to be compressive for all the tools used for dry turning, increasing the fatigue life of the machined component. Higher cutting temperatures were observed for coated tools due to its lower thermal conductivity, which results in very less tool wear than uncoated tools. Surface roughness with uncoated tools was found to be three times higher than coated tools due to lower coefficient of friction of coating used.

Keywords : cutting temperature, DSS2205, dry turning, HiPIMS, surface integrity
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