Friction behavior of different material systems at the nanoscale

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Recently, several physicochemical concepts and models have been used to explain the relationships between the nature or products of tribochemical reactions and friction. For example, deuterium chemisorbed on diamond or silicon surfaces lead to nanoscale friction coefficients lower than hydrogen chemisorbed on the same surfaces. This was attributed to the lower natural frequency of the carbon(silicon)-deuterium bond as compared to the carbon(silicon)-hydrogen bond, which implies a reduction in the rate at which the kinetic energy of the tip is dissipated. Other advances were reached based on a model, to be discussed below, that connects the ionic potential ($\phi$) and the average friction coefficient (AFC) of various oxides. The aim of this study is to investigate the friction behavior of three different material systems at the nanoscale focusing on the transition from nitrides to oxides as well as the influence of solid lubricant in a nanocomposite (MoS2-TiN). Nanoindentation experiments under different low loads were performed in order to analyze the friction behavior between a Berkovich tip and a surface up to approximately 260 nm in-depth. In both nitride-based material systems, the posterior oxidation of Si3N4 and Fe2-4N to SiO2 and Fe3O4, respectively, decreases the AFCs. In fact, the ionic potential ($\phi$) and the AFC of various oxides have a linear relationship. However, our behavior can be explained by the extension of the crystal chemistry approach from oxides to nitride compounds. Higher ionic potentials yield lower AFCs. In the case of the solid lubricant in nanocomposites there is an optimum amount of the lubricant nanoparticles (MoS2) embedded in the matrix (TiN) in order to decreases the AFC. Moreover, the AFC shows oscillations between minimum and maximum values that are following the wear track behaviors as observed by Atomic Force Microscopy.

Keywords
friction models
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