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Application of thick PVD coating for protection of particle erosion

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PVD deposited hard nitride coatings are used in the various fields such as tools, dies and machine elements. Erosion by high speed impinging solid particles can produce severe damage for the coated components such as turbine blades. Although the erosion of the coatings is known to be affected by deposition techniques and conditions, the effect of mechanical properties and erosion mechanism have not well explained yet.
Several types of PVD hard nitride coatings such as TiN were deposited using cathodic arc ion plating method on stainless steel substrates as simulating a machine component. These coatings were subjected to structural analysis such as XRD and TEM, and mechanical property investigation using nano-indentation measurement. Solid particle erosion resistance is evaluated using MSE (Micro-Slurry Erosion) method [1] using relatively large alumina hard particles (~ 50 microns) as erodent.
In case of TiN coatings which were deposited with different substrate biases, showed decrease in erosion rate as the substrate bias was increased. From the mechanical point of view, increase in substrate bias lead to increase in hardness. But also coatings preferred orientation was changed from (200) to (111) by the increase of substrate bias. EBSP (Electron Backscattering Pattern) analysis of the sample before and after a short erosion test indicate that crystal grains with (200) texture are preferentially removed by the particle erosion explaining increasing in erosion resistance as the substrate bias is increased. TEM analysis of the worn surface showed that lateral cracks were developing at the grain boundary between the grains with different crystallographic orientation. These change in structure and mechanical property brought a change in erosion property and these relationship will be discussed in more detail for TiN and other coating system.
[1] Y. Iwai et al ., Wear 251 (2001) 861–867

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