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Study of structural, optical and mechanical properties of TiN and TiCN thin films

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The primary emphasis of the research on nanocrystalline TiN and TiCN thin films is tuning the desirable properties of these materials for our use, i.e. tuning of hardness which makes them ideal candidates for wear resistant applications. This all resulted in considerable advances in the areas of tribology like dry cutting and metal forming, mechanical deformation behaviour and electrical transport properties of TiN and TiCN thin films [1,2]. In the present work, Ti thin films of about 200 nm thickness were grown on Si substrate by electron beam evaporation method. Further, these films were nitrided by low energy ion beam implantation technique. A beam of nitrogen ions with fixed ion current 1μA, energy 70 KeV and 1×10^{16} ions/cm^2 fluence was used in this process. After this one of the titanium nitride thin film was carbide with carbon ions at 1×10^{15} ions/cm^2 fluence.

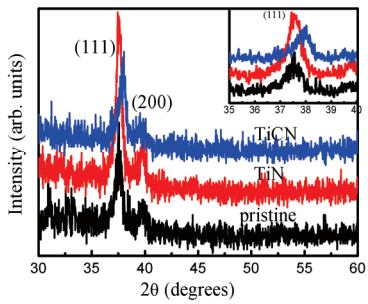

Figure 1: XRD pattern of pristine (Ti), TiN and TiCN

The XRD result of TiN film shows the shift in the (111) diffraction peak towards higher diffraction angle which demonstrate the strain in the film (Figure 1). Further shift was observed for TiN film after carbidation. AFM results confirm that the particle size (~20.65 nm, ~226 nm and ~124.73 nm) and roughness (~28.2 nm, ~234 nm and ~133 nm) varies for pristine, TiN and TiCN films simultaneously (Figure 2). The vertical force-displacement curves of pristine (Ti), TiN and TiCN have been shown in Figure 3. The band gap diminution from 3.09 eV to 2.13 eV was found for pristine to TiCN film which leads to enhancement in optical property. The hardness of ~1.31 GPa, ~1.33 GPa and ~1.35 GPa was measured for pristine, TiN and TiCN thin films.

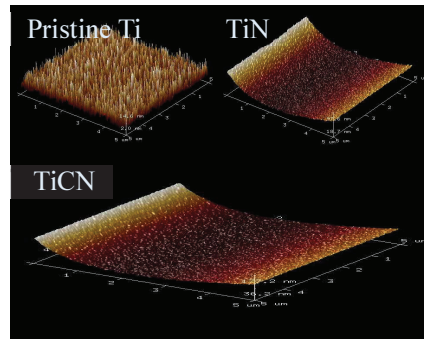

Figure 2: AFM images of pristine (Ti), TiN and TiCN

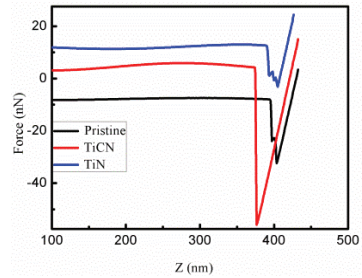

Figure 3: Vertical force-displacement curves of pristine (Ti), TiN and TiCN

Hence, the TiN films exhibit high hardness as compared to pure titanium but TiCN films have higher hardness in comparsion to both Ti and TiN. Other properties are also good such as structural, morphologcal and optical.

References

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