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Characterization of TiN thin film deposited by reactive DC unbalanced magnetron sputtering at different N2 flow rates

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Titanium nitride (TiN) thin films were deposited on Si substrates by reactive DC unbalanced magnetron sputtering from metallic Ti targets. The effect of N2 flow rate, in the range of 1.0–4.0 sccm with 1 sccm increment, on the structure of the as-deposited TiN films was investigated. The crystal structures were identified by the GI-XRD technique. The thicknesses, microstructures, and surface morphologies were observed by the FE-SEM technique. The elemental compositions were evaluated by the EDS technique. The hardnesses were measured by the nano-indentation technique. The film's colors were measured by the UV-VIS spectrophotometer. The results showed that the as-deposited films had an fcc structure with (111), (200), (220), and (311) planes. The lattice constant and the crystallite size were ranging from 4.211–4.239 Å and 17.8–24.6 nm, respectively. The as-deposited films showed a nanostructure with a crystal size of less than 25 nm. The thickness of films decreases from 1254 nm to 790 nm with increasing in the N2 flow rate. The elemental composition of the films (Ti and N contents) depended on the N2 flow rates. The cross-sectional analysis of films by the FE-SEM technique showed a compact columnar structure. The hardness of films measured by the nano-indentation technique was increased from 4.5–19.4 GPa with increasing in the N2 flow rates. The color of the film was measured in the CIE L*a*b* system showing that the film deposited with optimal N2 flow rates was close to the color of 24K gold.

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