Structural and mechanical properties of TiON nanocomposite films deposited on silicon by pulsed bias arc ion plating

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Abstract

Nanocomposite TiON thin films were deposited on p-(100) silicon substrate using a pulsed bias arc ion plating technique with the substrate bias ranging from 0V to -700V. XRD and TEM were used to characterize the phase composition and microstructure of the TiON films. Nanoindention tests were performed on the TiON films to obtain film hardness and elastic modulus so that the mechanical properties can be assessed. The results show that no apparent diffraction peaks are observed in the XRD pattern of the TiON film prepared at 0V, when the bias voltage increases (> -100V), the peaks of R-TiO2(101), TiN(111) and (220) are observed, indicating that substrate bias can exert a strong influence on the phase formation in the TiON films. TEM observation was performed on the TiON film obtained at -500V and the result shows that the crystal grain appears equiaxed, the grain size falls in the range of 20 _˜ 30nm, and the TiON film consists of rutile, anatase TiO2 and TiN phases, which is coincident well with XRD results. The TiON films fabricated with a pulsed substrate bias (-100V_˜-700V) applied exhibit higher hardness, more than 19GPa, while the TiON film fabricated without substrate bias shows lower hardness value, less than 11 GPa. With a substrate bias applied or not, the elastic moduli of the TiON films are high, more than 200GPa. In short, pulsed substrate bias can not only exert an obvious influence on phase formation and microstructure, but also mechanical properties of the TiON films.

Keywords: Nanocomposite film, TiON, Arc ion plating, Pulsed bias, Mechanical property

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