Young's modulus and Residual Stress Extraction of TaN Ultrathin Film

Yao-Zih Lai (yzlai@itri.org.tw) * 1 and 2, WEILEUN FANG (fang@pme.nthu.edu.tw) * 1

1 National Tsing Hua University
2 Industrial Technology Research Institute

Abstract: The mechanical properties extraction of the ultrathin film is a big challenge to be determined and controlled. In this study, we select a non-contact method to conduct the measurement of the TaN ultrathin film, which can effectively prevent to damage the TaN film at the same time. Firstly, we exploit the PVD process with various gas ratios to deposit the TaN thin film on the SiO_2 cantilevers. Then, we analyze the mechanical properties of the TaN thin film to extract the major characteristics. The frequency and geometry would dominate the performance of Young's modulus.

On the other hand, residual stress is accumulated by all the random stress induced during the process. Especially, uniform stress has a major impact on residual stress. Therefore, the uniform stress can be simplified as the residual stress and also can be expressed by the Stoney equation.

According to our experimental results, the N_2 gas ratios-dependent Young's modulus of TaN thin film is located at approximately 247.55±6.11GPa. In addition, the residual stress is reduced from -1.02GPa to -0.74GPa as the N_2 flow increases. Consequently, we provide an efficient approach to modifying the mechanical properties of ultrathin TaN film and the N_2 gas ratios can validate its mechanical properties during the deposition process.

Keywords: Young's modulus; Residual Stress; Tantalum Nitride; thin film; cantilever beam

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.