Study of processing parameters on the mechanical and compositional properties of plasma-enhanced atomic layer deposition aluminum nitride films.

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The mechanical and compositional properties of plasma-enhanced atomic layer deposition (PEALD) AlN films were examined under varying processing parameters. The results of this initial study indicate deposition temperature, plasma chemistry, and increasing the plasma source bias voltage significantly alter some key characteristics of PEALD AlN films. Residual stress, hardness, and density were observed to positively correlate with deposition temperature whereas Young’s modulus did not exhibit such a strong correlation. The choice of plasma chemistry, NH₃-based versus N₂H₂-based, was also found to significantly influence measured residual stress and hardness. Film stoichiometry and impurity content, particularly hydrogen, were observed to depend on processing conditions. While the PEALD AlN films are shown to normally be under tensile stress, depositing compressively stressed PEALD AlN was possible with increased bias voltage implying that careful control of bias voltage can enable stress-tuned ALD films. Deposition under increased bias voltage was found to lead to a universal improvement in film properties as increases in hardness, density, Young’s modulus values were measured in addition to a significant reduction in impurity content. The results demonstrate that processing conditions can strongly affect the mechanical properties of the PEALD AlN films and that high-bias voltage PEALD is an interesting area for further study.

Figures. Residual stress (left) and hardness (right) versus deposition temperature for PEALD AlN films with thermal ALD Al₂O₃ films (Ylivaara et al. Thin Solid Films (2014)) included as a reference.