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Influence of deposition time on microwave TMS/NH3 PECVD of a-SiCxNy:H thin films: from gaz phase to material chemistry and properties analysis.

Béatrice PLUJAT[1], Antoine GOULLET[2], Hervé GLENAT[3], Lawrence FREZET[4], Jonathan HAMON[2], Emmanuel HERNANDEZ[3], Sébastien QUOIZOLA[3], Laurent THOMAS[3]

[1]Laboratoire CNRS-PROMES, PERPIGNAN, France [2]Institut des Matériaux Jean Rouxel de Nantes, NANTES, France [3]Laboratoire PROMES-CNRS/UPVD, PERPIGNAN, France [4]Institut de Chimie de Clermont-Ferrand, AUBIERE, France

beatrice.plujat@promes.cnrs.fr

Plasma a-SiCN:H thin films can be used for numerous applications (optics, microelectronics, mechanics, solar energy) as their composition can be largely varied from nitrides (a-SiN:H) to carbides (a-SiC:H). Coupling of microwave plasma excitation (MW) with gas mixtures containing organosilicon precursors can lead to interesting high deposition rates, hence low industrial production costs, but film growth has to be precisely analyzed and controlled in terms of morphology, chemistry or electrical defects and thus, resulting properties, particularly for low film thicknesses applications. In this work, we focus on coatings growth modes of a-SiCN:H films obtained in Ar/Tetramethylsilane/NH_3 MW PACVD. Plasma phase has been first analyzed using Optical Emission Spectroscopy (OES) on H, H_2, N_2, NH, SiH/CH, C_2 and CN lines to correlate their evolutions versus TMS/NH_3 gas ratio to deposits compositions (FTIR, EDS) from nitride to carbide-like ones. Then, related materials were synthesized versus deposition times. According to morphology, roughness (Rq) obtained with Atomic Force Microscopy correlated with Abbott-Firestone treatment, and projected area vs developed area ratio, has shown two different alternate growth modes whatever deposit composition. However, thin films chemistry (FTIR, XPS) varied versus deposition time as confirmed by spectrocopic ellipsometry measurements, revealing the thermal aging of the material during growth. In addition, electrical spin defects have also been investigated by Electron Spin Resonance (ESR). Finally, influence of thermal budget during depositon has been investigated by post-deposition annealings. This work is supported by the French National Research Agency (HD-Plasm-A-SiNOC:H project: PROMES/ICCF/IMN/IJL french laboratories).

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SiCN:H Growth Mechanisms