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Study of non-thermal tetravinylsilane plasma by mass spectrometry

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Organosilicon films are an important part of many mechanical, optical, electronic and medical devices and are also necessary to optimize the surface properties of any type of material with respect to its application. By using low pressure PECVD, the non-thermal tetravinylsilane (TVS) plasma allows the deposition of organosilicon films with variable chemical and physical properties controlled by the input power. The power dependence of plasma species is investigated by mass spectrometry (Process Gas Analyzer HPR-30, Hiden Analytical, UK) and mass spectra are interpreted using the fragmentation patterns of the TVS molecule predicted by ACD/MS Fragmenter (Advanced Chemistry Development, Canada). Plasma species (TVS fragments, intermediates, by-products) are found to be products of electron impact dissociation in the plasma and chemical reactions at the surface of a growing film. Mass spectra contain many tens of fragments of different reactivity (non-radicals, monoradicals, biradicals, and higher-degree radicals or atoms, e.g., carbon) and their analysis leads to the selection of dominant species responsible for film growth. Power dependence varies for carbon species, silicon-containing species, and by-products such as hydrogen or methane molecules. The deposition rate evaluated by in situ spectroscopic ellipsometry correlates with the flux of plasma species hitting the film surface, including the probability of species binding. Thus, it is expected that the plasma species may be related to the elemental composition and chemical structure of the deposited material. The C/Si flux ratio in different plasma (different power) is related to the C/Si ratio in the deposited films characterized by Rutherford Backscattering Spectrometry (RBS). Also, the flux of vinyl-containing species in different plasma is related to the concentration of vinyl groups incorporated in deposited films characterized by infrared spectroscopy. Thus, some relationships between plasma chemistry and film chemistry are confirmed.

Keywords
thin film
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mass spectrometry
TVS fragmentation