Nanocrystalline diamond films: from growth to applications

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Due to an unique combination of physical and chemical properties, such as extreme hardness, high thermal conductivity, high breakdown field, negative electron affinity, p-type doping, high acoustic wave velocity, wide optical and electrochemical windows, chemical inertness, biocompatibility, diamond is an excellent candidate for mechanical, optical, thermal, biomedical and electronic applications. Owing to their small grain size leading to low surface roughness and low friction coefficient, nanocrystalline diamond (NCD) films are well adapted for nanotechnological applications, micro- and nanoelectrical mechanical systems (MEMS, NEMS), surface acoustic wave (SAW) devices, as well as for conformal coatings. In order to fulfill the requirements of such applications, the film intrinsic properties and therefore the synthesis process have to be controlled.

The talk reports on the investigation of the microwave plasma assisted CVD process used for NCD film deposition from $Ar/H_2/CH_4$ feed gas. Both permanent and pulsed microwave discharges are considered. The use of a pulsed wave is mainly motivated by the existence of two additional degrees of freedom compared to the continuous wave regime: the pulse repetition rate and the duty cycle. Various growth conditions obtained by varying these parameters, gas composition, input microwave power, pressure or substrate temperature, are examined. Film characteristics such as surface morphology and topography, structural properties, microstructure and electrical properties are discussed using real-time *in situ* optical monitoring, SEM, AFM, visible and UV Raman spectroscopy, XRD, TEM, and electrical measurements. Spectroscopic measurements and plasma modeling are also carried out in order to investigate the plasma phase characteristics in growth conditions. Optimized elaboration conditions are employed for achieving very high frequency SAW devices based on AlN/NCD layered structures. Experimental results show that a frequency up to 4 GHz is obtained for layered structure exhibiting a phase velocity of 9200 m/s with a lithographic resolution of 600 nm.

Keywords: Nanocrystalline diamond, microwave plasma, surface acoustic wave devices

Topic: Hard Coatings