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Synthesis and Electrical Characterization of n-Type Nanocrystalline Diamond Films by Microwave Plasma-Enhanced Chemical Vapor Deposition KUNGEN TEII, TOMOHIRO IKEDA, Kyushu University — Nanocrystalline diamond (nanodiamond) films are composed of three different carbon phases: the diamond phase in form of nano-sized grains, trans-polyacetylene segments, and amorphous carbon. They are typically formed under C_2-rich conditions by CVD in Ar-rich/CH_4 plasmas. n-type conductivity in nitrogen-incorporated nanodiamond films is attributed to the formation of electronic states associated with carbon and nitrogen in the grain boundary. However, the origin of the high n-type conductivity still remains unclear. The authors investigate structure and electrical properties of n-type nanodiamond films prepared from a microwave Ar-rich/N_2/CH_4 plasma. The authors also investigate the rectification properties of $p-n$ diodes using n-type nanodiamond films. The plasma was characterized by strong emission from C_2 radicals. The room-temperature resistivity of the films decreased exponentially by three orders of magnitude with deposition temperature and was saturated at $\sim 10^{-2} \Omega$ cm. The electron concentration increased up to 10^{20} cm^{-3}, while the mobility was between 1 and 10 cm^{2}V^{-1}s^{-1}. Arrhenius plots of the conductivity showed a transition from semiconducting to quasi-metallic conduction with deposition temperature. The amount and clustering of the sp^2 phase were found to affect strongly the electrical conduction properties.

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