C-V-f, G-V-f and Z"-Z' Characteristics of n-Type Si/B-doped p-Type Ultrananocrystalline Diamond Heterojunctions Formed via Pulsed Laser Deposition

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Through utilization of pulsed laser deposition, p-type B-doped ultrananocrystalline diamond (UNCD)/hydrogenated amorphous carbon (a-C:H) composite films were formed onto n-type Si wafer substrates at a substrate temperature of 550 °C. The capacitance-voltage (C-V), conductance-voltage (G-V) and the real part (Z') and imaginary part (Z") of complex impedance were measured at different frequencies (f) in the dark at room temperature. Based on the C-V-f and G-V-f plots at zero bias voltage, the series resistance (R_s) values were 1.72 kΩ at 40 kHz and 154.41 Ω at 2 MHz. The R_s should be attributable to the R_s existing in the metallic contact and bulk resistance in the active layer, which is the current-limiting factor of the n-type Si/p-type B-doped UNCD heterojunctions. The interface state density (N_{ss}) was estimated to be 1.40 + 10^{13} $eV^{-1}cm^{-2}$ at 40 kHz and decreased exponentially to 1.09 + 10^{12} $eV^{-1}cm^{-2}$ at 2 MHz. The calculated N_{ss} demonstrated a large number of interface states existing at the interface of the heterojunction, which acts as a leakage current center and a trap center for a photo-generated carrier. The Z"-Z' characteristic curve exhibited a semicircular curve. The Z"-Z' plot could be identified as an equivalent circuit model, which is comprised of R_s and resistance mounted in parallel with constant phase capacitance.