GEC19-2019-000193

Abstract for an Invited Paper
for the GEC19 Meeting of
the American Physical Society

High-rate deposition of high-density amorphous carbon films using a high-pressure plasma chemical vapor deposition

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Because of its mechanical strength, good wear resistance, high corrosion resistance and chemical inertness, high-density hydrogenated amorphous carbon (a-C:H) has garnered interest as a material for biotechnology, tribology, and protective coating technology. Here we aimed to establish a high density and high rate a-C:H deposition method using a parallel plate rf discharge plasma which is a promising method for large area deposition comparing with the conventional sputtering plasmas and arc plasmas. We succeeded in depositing a-C:H films at 36 nm/s for 7 Torr using Ar+CH_4(5%) discharges. The discharge region shrunk toward the discharge electrode for the higher gas pressure, while the maximum emission intensity increases, leading to a large flux of deposition precursors close to the powered electrode. We also succeeded in depositing the a-C:H of 1.8 g/cc at 81 nm/min using Ar+H_2+C_6H_8 plasmas with a substrate bias at 5 Torr. Effects of heavy hydrocarbon radicals, hydrogen atoms and energetic ions have been discussed.