GEC06-2006-000217

Abstract for an Invited Paper
for the GEC06 Meeting of
the American Physical Society

Micro Discharge Under Supercritical Conditions – Physics and Application to Materials Processing

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Recently, micro discharge or discharge microplasma have attracted much attention. Miniaturization of discharge or plasma allows us easy generation of discharge or discharge plasma under a high-pressure condition even up to supercritical fluid (SCF). Applying plasma to SCF processing may yield a high efficiency due to a combination of advantages of plasma and SCF. In addition, plasma generated in SCF is anticipated to contain radical and ion clusters, which may lead to novel physical/chemical phenomena and reactions, comparing to typical gas plasma. In our previous works, we succeeded in generating discharge or discharge plasma in high-pressure CO_2, H_2O, Xe up to supercritical conditions, and discovered novel phenomena, such as the drastic decrease in the breakdown voltages of 1 micrometer-gap electrodes near the critical point. Furthermore, we have applied SCF plasma to materials synthesis processings, and succeeded in fabricating carbon materials including carbon nanotubes (CNTs), under milder condition (31.1-70°C, 7.38-12 MPa) of scCO_2, as a processing media and starting raw material, with no catalyst [3], comparing to conventional thermal equilibrium processing. In this study, we generate stable low-temperature plasma using DBD (dielectric barrier discharge) in supercritical CO_2 and Xe conditions. In addition to its diagnosis by optical emission spectroscopy and Raman spectroscopy, application of it to film depositions of carbon nanomaterials and Cu will be discussed.