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Energetics of Reactions in a Dielectric Barrier Discharge with Argon Carrier Gas: the Case of Esters

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Plasma polymerization (PP) is the term used when a volatile organic compound ("monomer") is the reagent in a PECVD process. PP literature has long been interested in correlating deposition kinetics, physico-chemical and structural properties of deposited films, with energy transferred to the monomer molecules. In the case of atmospheric pressure (AP) dielectric barrier discharges (DBD), energy measurements are not trivial, because discharges usually are carried out in a flow of (inert) carrier gas (e.g. Ar or He) with typically parts per thousand (‰, or less) concentration of monomer. We can now perform accurate determination of energy absorbed by monomer molecules: In another communication in this symposium (M. R. Wertheimer et al.), we introduce a method for determining ΔEg, the energy difference with and without monomer in the Ar flow, and Em, the average energy absorbed per monomer molecule (in eV).
A large research reactor for DBD experiments at AP has been used with Ar carrier gas under constant plasma conditions (f = 20 kHz, Va(f) = 8 kVp-p = 2.8 kVrms). Five esters, acrylates with differing number of unsaturations were used as monomers; their flows, Fd, were at ‰ concentrations in the carrier flow, F = 10 standard liters per minute (slm) of Ar. Plots of Em versus Fd and 1/Fd yield much valuable information, for example about the role of C=C and C≡C bonds in fragmentation and polymerization reactions. Fourier-transform infrared (FTIR) spectroscopy, Spectroscopic Ellipsometry (SE) and Scanning Electron Microscopy (FEG-SEM) further enhance and complement data interpretation.

Keywords
Plasma polymerization
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