

Determination of active species in the modification of hardwood samples in the flowing afterglow of N₂ dielectric barrier discharges open to ambient air

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Sugar maple (*Acer saccharum*, Mill.) wood samples were exposed to the flowing afterglow of a N₂ dielectric barrier discharge (DBD) open to ambient air. Freshly-sanded wood surfaces were hydrophilized by the treatment. The dynamic behaviour of water droplets on hardwood samples further reveals a volumetric effect of treatment as well as a modification of the topmost surface. Analysis of the discharge properties by optical emission spectroscopy (OES) indicates that the neutral gas temperature (determined from the rovibrational spectrum of N₂) was close to room temperature, thus ruling out wood modification due to heat transfer. OES spectra combined with a collisional-radiative model also reveals significant concentration of metastable N₂(A) states and UV photons (in particular those from the NO γ system in the 200–300 nm range) in the discharge. To better examine the role of UV irradiation, wood samples were exposed to the late afterglow of a low-pressure N₂/O₂ plasma optimized for UV emission from the NO systems. Wood hydrophilization was observed only for samples directly exposed to the late afterglow and not for those contained in a UV-transparent enclosure. Wood hydrophilization in the DBD is thus not directly related to UV irradiation; these energetic photons rather participate [along with N₂(A) metastables] in the formation of other active species, in particular atomic oxygen and ozone due to the open-air configuration. The role of ozone was confirmed by treatments in an ozone generator, showing dynamic wettability comparable to the ones achieved after treatment in the flowing afterglows of the atmospheric-pressure N₂ DBD and low-pressure N₂–O₂ plasma. FTIR spectra of wood samples treated in the three systems (DBD, N₂–O₂ plasma, and ozone generator) indicate an increased lignin content due to the possible development of lignin precipitates, corroborating the effect of atomic oxygen and ozone.