The transport and surface reactivity of O atoms during the atmospheric plasma etching of hydrogenated amorphous carbon films

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Abstract

A remote microscale atmospheric pressure plasma jet with a He/O2 gas mixture is used to etch a hydrogenated amorphous carbon layer. The etched profiles are measured by means of imaging spectroscopic reflectometry, a powerful technique providing a 2D map of the film thickness (etched profile) and also film properties. Additionally, the 2D axially symmetric fluid model of the gas flow and species transport combined with the basic kinetic model of the reaction of O atoms with O2 molecules has been solved to study the transport and surface reactivity of O atoms. The model provides a spatially resolved and surface-integrated O atom loss rate at the surface. The situation with convection-dominated species transport and fast recombination reactions of O atoms in the volume leads to a strong dependence of the etched profile on the O2 admixture and O atom surface loss probability ɓ. By comparing etched profiles with the simulation results, the O atom surface reaction probability of ɓ = 0.2%ï0.6% could be estimated. The modeled O atom loss rate at the surface was always higher and with the same trend as the etching rate, corroborating that O atoms are the main etching species. The presented data and simulation results show that the fastest surface-integrated etching rate is achieved not under conditions with the highest O density on the jet axis, but at lower O2 admixtures due to reduced recombination losses in the gas phase.

Plasma Sources Science and TechnologyJournal 2019, March