Structural studies of carbon dust samples exposed to NSTX plasma

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Raman analysis has shown that the production of carbon dust particles in NSTX involves strong modifications of the physical and chemical structure of the original graphite. Raman spectra were measured for different dust samples exposed to the NSTX plasma, unexposed dust samples, carbon deposits produced in an atmospheric pressure helium arc discharge, and heat-treated carbon samples. The arc electrodes and heat-treated samples were made from the same graphite material as the NSTX tiles. For the unexposed particles, the high energy G-mode peak (Raman shift ~1580 cm^{-1}) is much stronger than the defect-induced D-mode peak (Raman shift ~ 1350 cm^{-1}), a pattern that is consistent with Raman spectrum for commercial graphite materials. For dust particles exposed to the plasma, the ratio of G-mode to D-mode peaks is lower and becomes even less than 1. This behavior indicates on a strong increase of structural disordering in plasma exposed samples. We also demonstrate experimentally that heating to 1500-2500 °C alone can not explain the observed structural modifications indicating that they must be due to higher temperatures needed for graphite vaporization, which is followed either by condensation or some plasma-induced processes leading to the formation of more disordered forms of carbon material than the original graphite. Moreover, because we found similar plasma-induced structural modifications in dust particles exposed under the different background gases (hydrogen and helium) and the different plasma conditions of the arc and NSTX experiments, our results suggest that the observed structural modifications can be unrelated to hydrocarbon compositions on the dust surface or implantation or thermal diffusion.

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