Modelling of argon-acetylene dusty plasma

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The properties of an Ar/C_2H_2 dusty plasma (the ion, electron and neutral particle densities, the effective electron temperature and the dust charge) in glow and afterglow regimes are studied using a volume-averaged model. The model accounts for different loss and production processes of neutral species and ions in the plasma, including the losses on the dusts, dissociation and ionization of acetylene molecules in collisions with argon atoms in excited states as well as the loss of anions in collisions with hydrogen atoms. The most important processes are determined. The numerical calculations are carried for Maxwellian and Druyvesteyn electron energy distribution functions (EEDFs). The calculated mass-distributions of neutral species and positive ions are compared with the mass spectra obtained in our experiment and found to be in a good qualitative agreement. Effects of variations of the input power, EEDF and dust particle densities and radii on the plasma properties are investigated. It is shown that the densities of most hydrocarbon ions are smaller in the plasma with large dust charge density comparing with the dust-free case, while the argon ion density is larger in the former case. The ion density differences are found to be due to larger electron temperature and smaller electron density in the dusty plasma. It is also found that the acetylene density is larger in the dust-free case as compared with that in the dusty plasma. It is obtained that dust particles affect essentially the ion densities in the plasma as well as the density of atomic hydrogen. Numerical calculations also showed that argon atoms in excited states affect the production of $C_2H_2^+$, $C_4H_2^+$, C_2H and H as well as the loss of C_2H_2, C_4H_2 and H_2. The loss of C_2H^- anions in the plasma is found to be mainly due to the anions' collisions with positive ions and atomic hydrogen. It is also discussed how dust particles affect the EEDF.