Generation and characterization of hydrogen amorphous carbon nitrile particles and mass spectrometric study of the CH_4/N_2 radio-frequency plasma.

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Amorphous carbon nitrile particles are generated in low pressure radio frequency (rf) plasma (13.56 MHz) in CH_4/N_2 gas. The mass spectrometry is used to identify neutrals species and ions in the dusty plasma. Neutral CN and/or C_2H_2, HCN, CH_4 and/or NH_3… radicals have been detected. In order to compare the plasma and the particle compositions, the particles are collected and characterized by EDS measurements and Fourier Transformed Infrared spectroscopy (FTIR).

Amorphous carbon nitrile particles are generated in low pressure radio frequency (rf) plasma (13.56 MHz) in CH_4/N_2 gas. A $CH_4/\ N_2$ mixture is used as feed gas and injected with a constant total flow rate of 5.6 sccm ($9.45\ 10^{-3}$ Pa.m ^{3}.s $^{-1}$). Throughout our experiments, the working pressure is 120 Pa and the incident rf power ranges between 40 and 140 W.

The CH_4 and N_2 dissociation leads to particle formation and growth in the plasma bulk. The plasma chemical composition is modified during the particle generation [1].

The mass spectrometry is used to identify neutral species and ions in the $CH_4/\ N_2$ dusty plasma. These reactive plasmas are complex and it is rather difficult to distinguish two peaks of slightly different m/z. However, the nitrogen addition changes the methane plasma composition. Therefore, different plasmas have been investigated: N_2 plasmas, CH_4 plasmas and CH_4/N_2 ones. Neutral CN and/or C_2H_2, HCN, CH_4 and/or NH_3… radicals have been detected.

In order to compare the plasma and the particle compositions, the particles generated in a 30% CH_4/ 70 % N_2 gas mixture are collected and characterized. The quantitative chemical analyses and the chemical bonds are investigated using EDS measurements and Fourier Transformed Infrared spectroscopy (FTIR). Increasing incident rf power leads to the emergence and the rise of an absorption band in the range 2000-2300 cm^{-1}, related to the triple-bonded -C≡N nitrile (2245 cm^{-1}) and C≡N- isonitrile structures (2100cm^{-1}, 2175 cm^{-1}) [2]. Increasing the rf incident power promotes the CH_4 and N_2 dissociations leading to the formation of CN bonds in the particles. Moreover, whatever the incident rf power, the quantitative chemical analyses shows that the atomic proportion of C, N and O in the particles does not change. The nitrogen incorporation depends only on the nitrogen content in the gas mixture. No significative changes in the nitrogen atomic proportion have been evidenced for an incident rf power range 40 -140 W.

References

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