Carbonaceous nanoparticles in cold hydrocarbon plasmas

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A significant fraction of cosmic dust is made of carbonaceous material [1]. Carbonaceous grains originate characteristic IR absorption bands revealing the presence of aliphatic and aromatic functional groups in variable proportions. At present, the most likely carrier of the observed IR bands is believed to be some sort of hydrogenated amorphous carbon (abbreviated HAC or a-C:H), but the detailed composition and structure of the grains are still not clear and under intensive investigation.

In the present work we follow the method of Winter and co workers [2] and use capacitively coupled radio frequency plasmas of C_2H_2/Ar and C_2H_2/He to induce the gas-phase formation of HAC particles as analogs of interstellar (IS) dust in a process expected to be close to the actual conditions of IS dust formation. We have studied the time evolution of dust aggregation in the discharge and have characterized both the gas phase and the dust with various diagnostic techniques.

Dust is typically formed in cycles of several minutes. The time evolution of dust aggregation in the discharge is observed using laser light scattering recorded with a charged coupled device (CCD) camera. Information about the evolution of gas-phase species during particle formation is derived from optical emission spectroscopy and from quadrupole mass spectrometry of neutrals and ions. Finally, the dust produced in the plasma is collected and analyzed ex-situ with Fourier Transform Infrared (FTIR) spectroscopy. The infrared spectra of the collected HAC samples show variations that depend on the precursors and discharge conditions.

In the analysis of the measurements we try to relate the data from the gas-phase diagnostics and the process of particle formation. The results are discussed in the light of astronomical observations and, whenever possible, compared to previous work.

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References

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