Analogs of interstellar carbonaceous dust: processing by electron bombardment and theoretical modeling

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Observational evidence, based on IR absorption spectra, indicates that interstellar (IS) carbonaceous dust in the diffuse interstellar medium is largely made of some sort of hydrogenated amorphous carbon (abbreviated HAC o a-C:H). Observations also show that the most prominent spectroscopic feature associated with the aliphatic component of IS carbonaceous dust (the 3.4 μm absorption band) disappears in dense molecular clouds, although the details of the destruction mechanism are not entirely clear. The effects of cosmic rays, which can reach the interior of dense clouds, on the carriers of this feature, have been investigated in this work by irradiating HAC samples with 5 keV electrons. High energetic electrons had proved previously [1] to have similar effects to MeV ion beams of different species tested in laboratory, which are usually accepted as good analogs of cosmic rays [2]. The HAC deposits were grown by plasma enhanced chemical vapor deposition (PECVD) in inductively coupled RF discharges of CH_4/He mixtures. The estimated effects are found to be small and are not enough to explain the disappearance of the 3.4 μm band in dense clouds.

On the other hand, two alternative models of the structure of the carbonaceous dust analogs can be found at present in the literature. One of them favors a solid made by small aromatic islands linked by aliphatic chains [3], whereas the other proposes large polyaromatic structures with small aliphatic substituents at the edges [4]. Theoretical models of amorphous HAC solids, based on the mentioned competing structures [3,4], have been constructed by our group using Density Functional Theory (DFT), and their calculated IR spectra have been compared to those of a-C:H samples generated by PECVD. The deposition conditions were selected to obtain a-C:H films with a variable proportion of aliphatic and aromatic structures. The results suggest that the estimation of the hydrogen contents and the aliphatic/aromatic ratios of a-C:H samples, using just literature IR band strengths advanced by some authors [5], is difficult and might be not reliable.

References

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