IR Spectroscopy of Solids Containing Si-H Bonds: Source of the Interstellar 4.62 micron Absorption Feature?

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Recent mid-IR observations of a number of embedded protostars by Pendleton et al. (1998) clearly reveal the general presence in dense molecular clouds of a broad absorption feature at 2165 cm^{-1} (4.62 μm). While this feature is often referred to as the "XCN band", its source has not yet been conclusively identified. Two broad catagories of astrophysically relevent materials—nitrogen-bearing species such as nitriles, and compounds containing Si-H bonds—are known to absorb in the 2200–2100 cm^{-1} spectral region on the basis of laboratory spectroscopy of individual molecules (both free and isolated in polar and nonpolar ices), and of energetically processed ice mixtures. In this work, thin films of *a*-Si:H and *a*-Si(x)C(1-x):H were produced by plasma enhanced chemical vapor deposition from silane, silane/methane mixtures and from tetramethylsilane, oxidized by exposure to the atmosphere and UV radiation, and characterized by IR absorbance spectroscopy. It is shown, consistent with other published reports (i.e., Moore, Tanabe & Nuth 1991, Strazzulla et al. 1998), that the Si-H stretching frequency is variable in the range 2200–2100 cm^{-1}, depending on the electronegativity of the other heavy atoms bonded to Si in the solid. The Si-H band in freshly deposited *a*-Si:H and *a*-Si(x)C(1-x):H is observed at 2100 cm^{-1}, and found to shift through 2165 cm^{-1} to 2200 cm^{-1} and broaden as the materials oxidize. *a*-Si(x)C(1-x):H appears to oxidize more rapidly and thoroughly than pure *a*-Si:H, producing an absorption feature at 2165 cm^{-1}, but this feature is much broader than that observed in dense molecular clouds.

While these experiments do not completely rule out the possibility that the 2165 cm^{-1} interstellar absorption feature observed in dense molecular clouds is due to oxidized *a*-Si(x)C(1-x):H, they do highlight a problem with this and other identifications: the feature appears to be remarkably constant in frequency in astrophysical environments and remarkably variable in the lab.

References:

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