SOLID INDENE PURE AND IN WATER ICE: INFRARED SPECTRA AND DESTRUCTION CROSS SECTIONS

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In 2021, the first pure PAH molecule, indene, was finally detected in the cold pre-stellar core TMC-1[a], with an estimated gas-phase abundance of 1 - 1.6 10^{-9} with respect to H_2. The observed high relative abundance of indene in cold molecular clouds raises the question about the cycling of this molecule between the gas and the ice mantles of dust grains, and further modeling and laboratory data are required to understand these processes.

The present work is focused on the IR spectroscopy of solid phases of indene at low temperatures that, to our knowledge, have not been reported previously. Using the same experimental setup described in our previous works on urea[b], IR spectra of vapor deposited amorphous and crystalline indene and of indene mixtures with water ice have been recorded. Solid structures and vibrational spectra have been calculated using density functional theory and the results of the calculations have been used for the assignment of the measured IR spectra. Experimental and theoretical band strengths have also been determined. The IR spectra provided are expected to guide the possible detection of this species in the solid phase with the JWST. Our results suggest that some weak absorptions tentatively attributed to mixtures of large PAHs in the IR spectra of interstellar ices[c]) should have a large contribution of indene and other small aromatic hydrocarbons.

Additionally, experiments on energetic processing of indene ices with 5 keV and VUV photons have been performed, to mimic the effect that Cosmic Rays and the secondary UV field, respectively, will have on this species if present on the surface of dust grains in dense clouds. Indene radiolysis and VUV photolysis destruction cross sections have been derived.[d]

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[a] Cernicharo et al. 2021, A&A 649, L15; Bukhardt et al. 2021, ApJL, 913:L18

[b] Maté et al. 2021, PCCP, 23, 22344; Herrero et al.2022, MNRAS 517, 1058–1070

[c] E. Chiar et al. 2021, ApJ, 908, 239

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