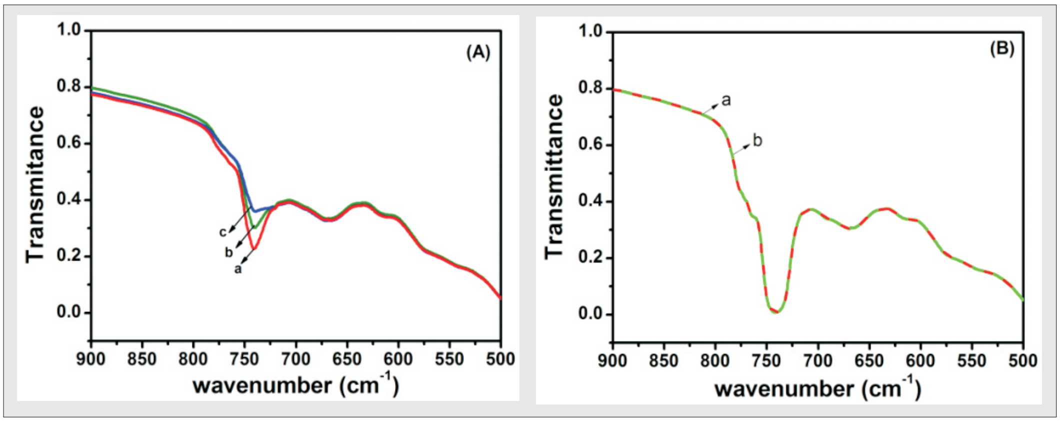
$^{98/100}$Mo Enrichment by Infrared Multi-photon Dissociation of MoF_6



FTIR spectra depicting the absorption feature corresponding to ν*3 IR active vibrational mode of* MoF_6*. A: when the MPD cell was partially passivated. The increasing transmission with passage of time (spectra a, b, c recorded with a 15 minute gap) indicates the undesired loss of* MoF_6*. B. MPD cell satisfactorily passivated. Spectra a & b recorded with a gap of ~18 hours.*

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A methodology was successfully worked out to address the handling problem of the working molecule MoF_6 during IRMPD experiments.

In spite of the large and ever-increasing demand for Tc^{99}, and, in turn, the isotopes of Mo worldwide, the literature on IRMPD of MoF_6 is rather scanty owing to the difficulties faced in handling this working molecule. Presence of moisture, even in slightest quantity, can result in the formation of the highly corrosive HF gas that etches away the container material, the sealants, the windows, and every other surface that it comes in contact with. Thus, although IRMPD is an established technique, the lack of research activity with MoF_6 is due to the paucity of knowledge in handling this gas for such experimental procedures. A methodology was successfully worked out to address the handling problem of the working molecule towards realizing enrichment of the desired isotope (M. B. Sai Prasad *et al.*, *$^{98/100}$Mo Enrichment by Infrared Multi-photon Dissociation of* MoF_6, Chemical Physics Letters, 2022, **787**, 139262). Firstly, the experimental cell and the associated tubings, constructed of Monel and sealed with corrosion resistant gaskets (perfluoroelastomers) were evacuated to yield a leak rate better than 10^{-9} mbar-lit/sec. The trapped moisture was removed from the chamber by its repeated evacuation and baking. The surfaces were passivated by repeated exposure to fluoride environment followed by evacuation using the heat and thaw cycle approach. Care was taken to break the vacuum only in extremely pure Nitrogen atmosphere to protect this surface passivation. Our experience has shown that the acquired surface resistance to the corrosive MoF_6 is short lived and fragile necessitating the affirmation of gas content in the cell from time to time and repeating the passivation procedure when required. The ability of the chamber to contain MoF_6 was ascertained from the FTIR spectra recorded as a function of time as shown in the figure below. Experiments of IRMPD of MoF_6 have been carried out both at room temperature and under cooled condition (-58^{0}C), by targeting its combination mode (v_3+v_5) utilizing a 100Hz pulsed CO_2 laser (Impact 300, Light Machinery make). A maximum enrichment factor of ~1.12 for the case of ^{100}Mo was achieved upon irradiation with the laser operating on 9P(10) line that is near-resonant to $^{92}MoF_6$. Although the laser was capable of emitting ~2J/ pulse, the coupled energy into the cell was restricted to ~800 mJ due to the optical damage of the dielectric coated windows of the cell. It is a well known fact that IRMPD is an intensity driven process requiring a single isotopic species to absorb several tens of photons. Usage of uncoated optics should allow coupling of higher energy and in turn improved enrichment.

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