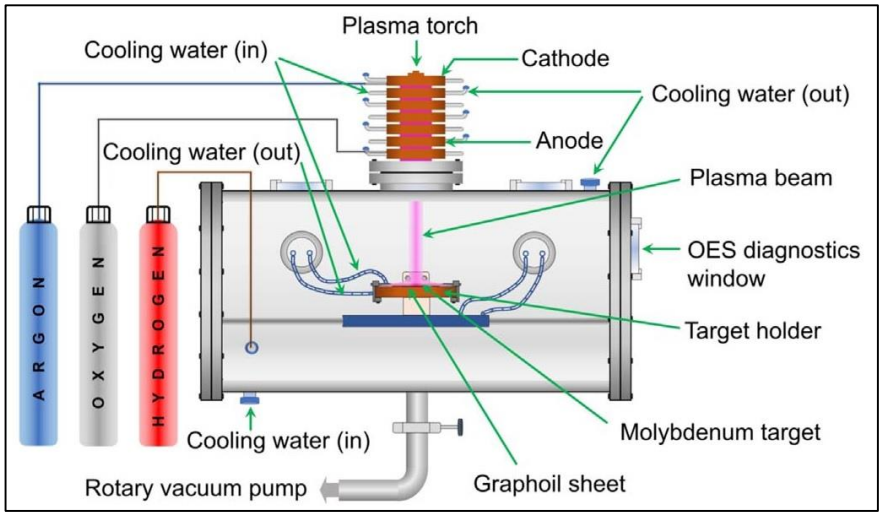
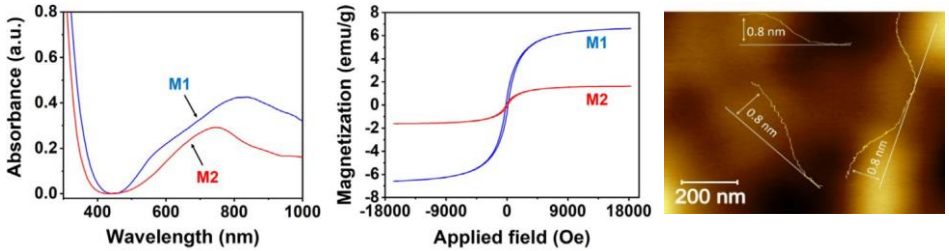
A single-step plasma method for rapid production of 2D, ferromagnetic, surface vacancy-engineered MoO_{3-x} nanomaterials, for photothermal ablation of cancer

Mizanur Rahman, Deepak B Pemmaraju, USN Murty, Sarat Phukan, Uday P Deshpande, Vasant Sathe and Mayur Kakati



Caption: The plasma chemical experimental reactor configuration for synthesis of the nanomaterials



Caption: (left): UV-Vis absorption spectra of MoO_{3-x} (M1: Synthesized at low plasma power, 7.8 kW & M2: Synthesized at high plasma power, 17.3 kW); (middle): RT ferromagnetic hysteresis curves and (right): AFM micrograph of MoO_{3-x}.

- CPP-IPR CIMPLE-PSI laboratory developed a new, plasma technique for very rapid production of atomically-thin molybdenum-oxide nanomaterials with controlled surface oxygen-vacancies, maximum up to 200 g/h.
- Surface defects endowed the nanomaterial with multiple superior properties, including robust room temperature ferromagnetism (saturation magnetization 5.68 emu/g), ability to heat up through absorption of near infrared (NIR) light and lastly, easy dispersibility in aqueous solutions even without using any surfactants.
- As-synthesized nanomaterials are also found to be perfectly biocompatible in animal physiological environment, as confirmed by standard hemolysis analysis.

Source: Nanotechnology, 34, 195601, 2023
Published Paper Link: https://doi.org/10.1088/1361-6528/acb827

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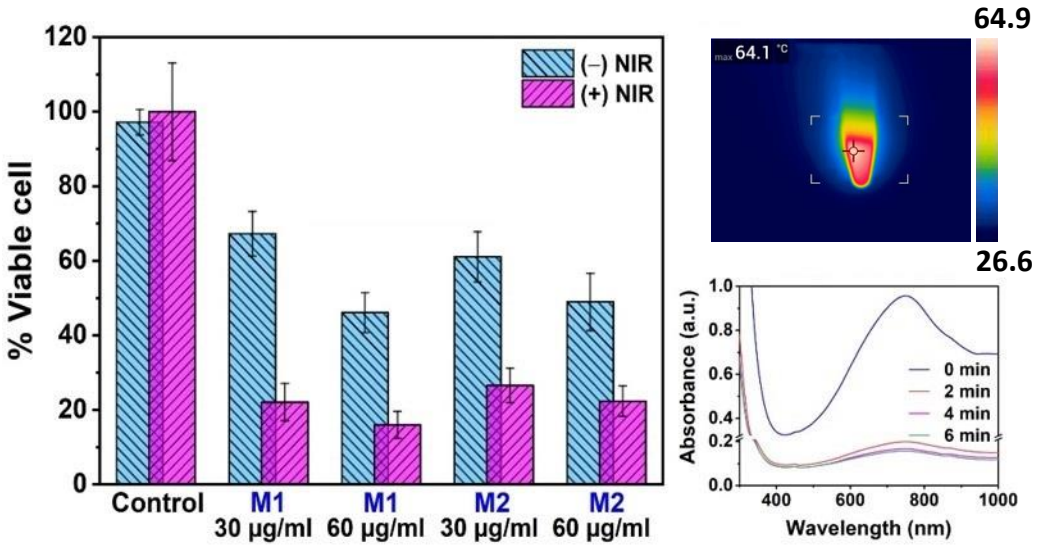

Caption: *In-vitro* photothermal cytotoxic effect of plasma synthesized molybdenum oxide nanomaterials towards melanoma (B16F10) cancer cells; (right, top): representative thermal image of aqueous solutions after 10 min irradiation with NIR laser and (right, bottom): UV-Vis absorbance spectra of nanomaterial solution at different durations of NIR laser exposure

- Collaborating with National Institute of Pharmaceutical Education and Research (NIPER) Guwahati, it was demonstrated through *in-vitro* studies that the plasma synthesized MoO_{3-x} nanomaterials could be utilized as a cheaper alternative for photothermal treatment of human melanoma (A375) and murine melanoma (B16F10) cancers.
- The products are observed to be very stable even under prolonged exposure to the atmosphere, but may get self-degraded during the photothermal heating, which will ensure their excretion through the renal system of the body.
- Being ferromagnetic, the photothermal nanomaterial agents may be manipulated with a simple external magnetic field for targeted delivery at the malignant tumors, which will further reduce long-term side-effects on healthy organs.

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