Researchers propose novel dichroic laser mirror design with mixture layers and sandwich-like-structure interfaces

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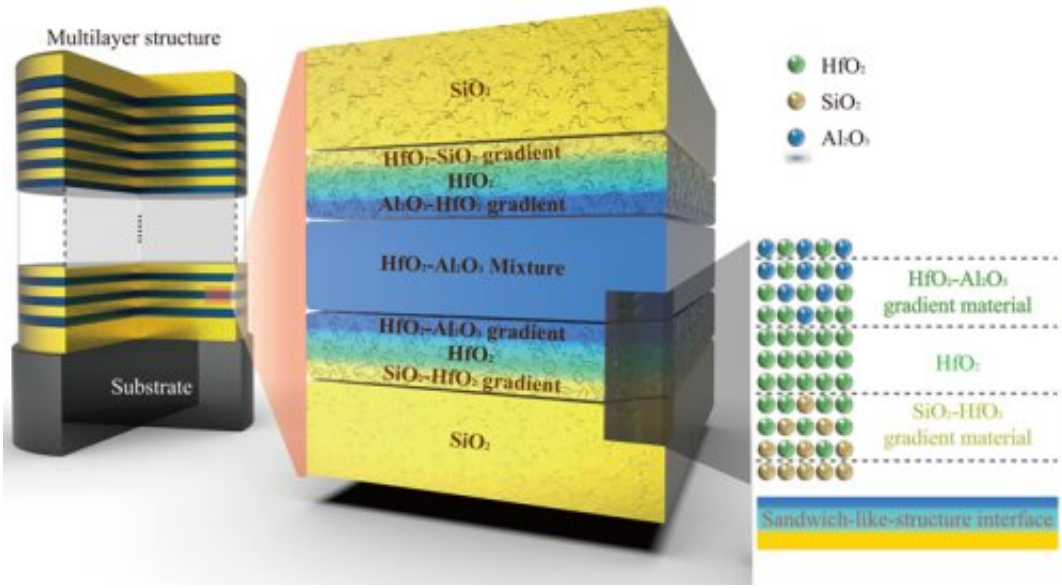

Fig. 1. Schematic diagram of the proposed MDLM design. Credit: SIOM

Recently, a research team from the Shanghai Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences (CAS) proposed a new design with mixture layers and novel sandwich-like-structure interfaces to meet the challenging requirements of the ideal dichroic laser mirrors. The research article was published in *Photonics Research* on Jan. 27, 2021, and was highlighted as an Editor's Pick.

Dichroic laser mirrors are usually used as harmonic separators, beam combiners or splitters. They play an important role in many laser applications, including inertial confinement fusion laser, petawatt femtosecond laser, high power fiber lasers, compact Q-switched or mode-locked lasers, and other emerging lasers. The requirements for dichroic laser mirrors continue to increase with the development of laser technology. The ideal dichroic laser mirror for high power lasers requires a significantly different reflection or transmission property and a high laser-induced damage threshold (LIDT) at two different wavelengths of interest simultaneously.

Unfortunately, traditional dichroic laser mirrors (TDLM) composed of alternating high- and low-refractive-index (n) pure materials often have difficulty in achieving excellent spectral performance and high LIDTs at two wavelengths simultaneously. There is a trade-off between the required optical performance and LIDT.

In this work, the researchers designed and prepared a mixture-based dichroic laser mirror (MDLM), which uses HfO_2-Al_2O_3 mixture material as a high-n layer with adjustable n and optical bandgap, and pure SiO2 as a low-n material. The interface between the low-n SiO_2 layer and the high-n HfO_2-Al_2O_3 mixture layer is a sandwich-like-structure interface ("SiO_2-HfO_2 gradient material | HfO_2 | HfO_2-Al_2O_3 gradient material"), which replace the traditional discrete interface.

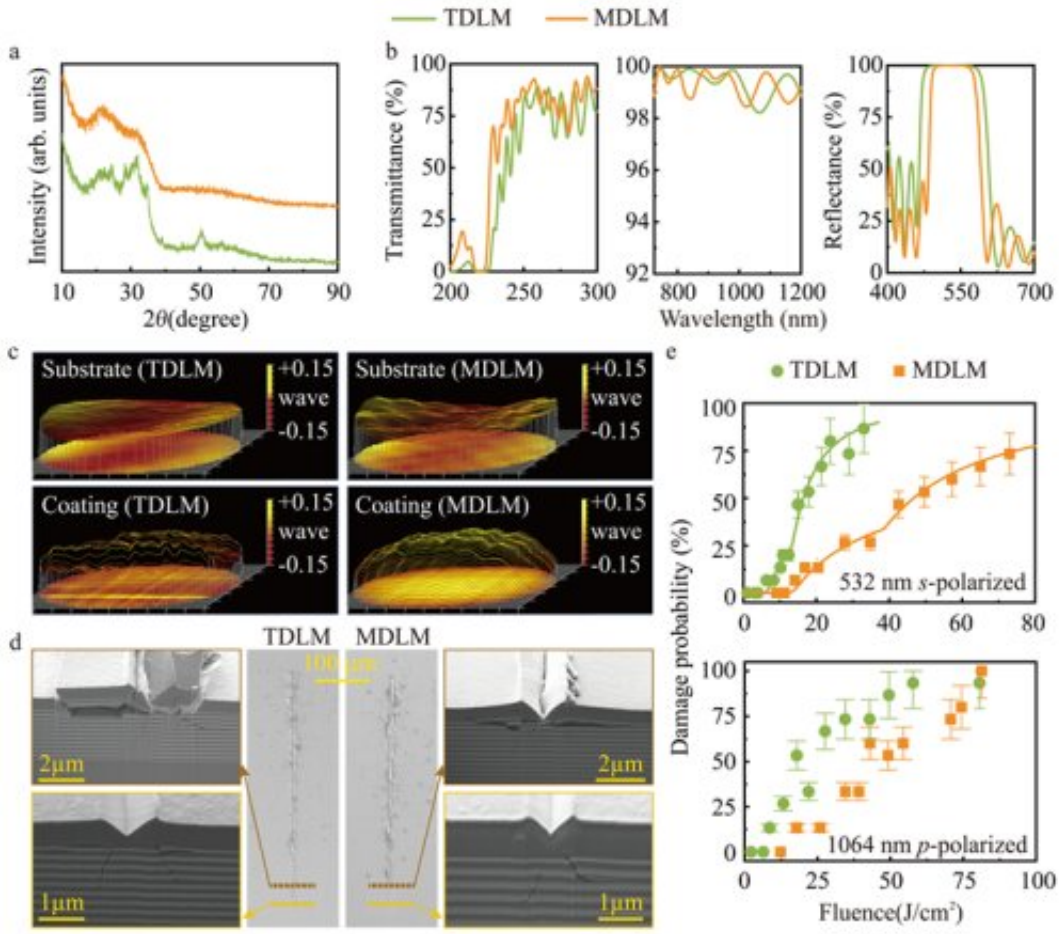

Fig. 2. Microstructure and optical property of the TDLM and MDLM coatings. Credit: SIOM

The MDLM shows excellent spectral performance and improved performance over TDLM with finer mechanical property, lower absorption, and higher LIDT. For both the s-polarized 7.7-ns pulses at a wavelength of 532 nm and the p-polarized 12-ns pulses at a wavelength of 1,064 nm, the LIDTs are almost doubled.

This MDLM design strategy opens new avenues for improved dichroic mirror coatings and other laser coatings and can benefit many areas of laser technology that rely on high-quality laser coatings.

More information: Tingting Zeng et al. Dichroic laser mirrors with mixture layers and sandwich-like-structure interfaces, *Photonics Research* (2020). DOI: 10.1364/PRJ.411372

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