Pulsed laser deposition of Ho_2O_3 thin films for Nano-Photonics

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The realization of a compact X-ray laser on a chip is a overdue challenge, with the initial concept proposed by Fisher in 1974 [1]. This concept based on using a single crystal as a distributed feedback resonator, achieving resonance coupling between lattice planes and X-rays. Detailed calculations on various Röntgen materials have been conducted [2], indicating the need for 100 nm cubic crystals. Additionally, stoichiometry of the material plays an important role, dictating the lattice parameter of the crystal. Hence, we chose to employ pulsed laser deposition (PLD) to fabricate them. Ho_2O_3 was identified as a potential material for realizing an X-ray laser on a chip.

In this study, we focused on optimizing the growth of Ho_2O_3 thin film on an yttrium-stabilized zirconia substrate (YSZ) for the first time. The quality of the grown crystal was characterized using X-ray methods such as X-ray reflectivity (XRR) and reciprocal space mapping (RSM), among others. Additionally, surface morphology was analyzed using atomic force microscopy (AFM). The grown thin film was confirmed to be epitaxial, with a thickness of approximately 33 nm.

[1] Fisher, Robert A. "Possibility of a distributed-feedback x-ray laser." Applied Physics Letters 24, no. 12 (1974): 598-599.

[2] Rameshbabu, Sharath, and Davide Bleiner. "Röntgen materials for x-ray lasers-on-a-chip." In Compact Radiation Sources from EUV to Gamma-rays: Development and Applications, vol. 12582, pp. 95-103. SPIE, 2023.