Pulsed Laser Deposition of ''Röntgen Nano Films''

Sharath Rameshbabu[a,b], Davide Bleiner*[a,b]

[a]Swiss Federal Laboratories for Materials Science and Technology (Empa), Überlandstrasse 129, 8600 Dübendorf.

[b]University of Zürich, Winterthurerstrasse 190, 8057 Zürich, Switzerland.

E-mail: Sharath.rameshbabu@empa.ch

In 1974, Fisher [1] proposed the concept of utilizing single crystals to generate an incredibly small X-ray laser. Yariv [2] calculated the lasing parameters in the single crystals to achieve distributed feedback. The core of this laser lies in the resonant matching between the wavelength and the interplanar distance of the crystal. Due to the strict requirements of crystal quality and stoichiometry, that theoretical underpinning never made its way to an experimental system.

This work's long term objective is the experimental realization of such a miniature X-ray laser. "Röntgen material" signifies crystals that are active as gain media. Detailed calculations on various ''Röntgen materials'' have been performed to evaluate the performance at various X-ray wavelengths [3]. From those materials, one of the potential candidates was selected for this experimental work, namely Ho_2O_3. The calculated results provided the dimension for the single crystal, which turns out to be around 100 nm. To create such a tiny crystal, we employed pulsed laser deposition (PLD) to grow an epitaxial thin film. PLD is well known for its stoichiometry transfer and epitaxial growth of thin films [4]. This is most important in our case. Ho_2O_3 is a robust candidate to grow as a thin film due to its chemical stability.

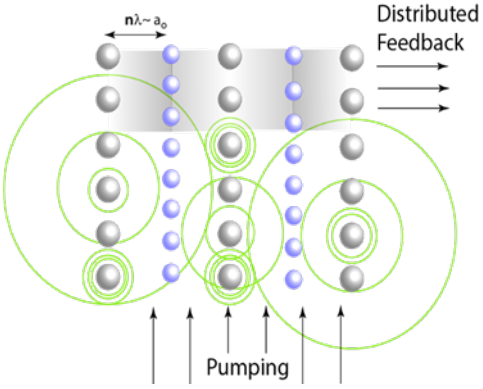

Fig.1 Lasing principle of single crystal X-ray laser.

[1] Fisher, Robert A. *Applied Physics Letters* 24, **1974**, 12, 598-599.

[2] Yariv, Amnon. *Applied Physics Letters* 25, **1974**, 2, 105-107.

[3] Sharath Rameshbabu, Davide Bleiner. SPIE Optics and Optoelectronics **2023**, 2, 12582-42 (In-press).

[4] Shepelin, Nick A., Zahra P. Tehrani, Natacha Ohannessian, Christof W. Schneider, Daniele Pergolesi, and Thomas Lippert. *Chemical Society Reviews*, **2023**, 52, 2294-2321.