Exploring laser ultra-fast ablation techniques on UO_2: Advancements in Nuclear Fuel Micro-Machining

C. Cifuentes Quintal[1, 2*], T. Doualle[1], Y. Pontillon [1], and L .Gallais[2]

[1] CEA, DES, IRESNE, DEC, Cadarache F-13108 Saint-Paul-Lez-Durance, France
[2] Aix Marseille Univ, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France
[*]Corresponding author email: Carlos-Esteban.CIFUENTESQUINTAL@cea.fr

In the field of nuclear energy, advancing reactor technologies require the precise study of nuclear fuel behavior under different irradiation conditions, driving a shift towards localized data analysis within the fuel pellet. However, challenges remain in obtaining appropriately sized samples for thorough investigation, typically ranging from a few hundred microns to a millimeter.

Building upon preliminary studies conducted on model materials [1], our methodology focuses on applying sub-pico laser ablation for micromachining to manufacture samples made of uranium dioxide (UO_2). By integrating a numerical model to calculate thermal effects and pairing it with surface temperature measurements obtained using a high-speed thermal camera, our study aims also to quantify and minimize the heat-affected zone. Such control of the affected zone is essential to preserve the microstructure and inherent properties of the samples under investigation.

In this talk, we present our first results to produce samples within a vacuum chamber under controlled atmospheric conditions together with corresponding thermal behavior modelling.

The transition from model materials to UO_2 samples marks a significant advancement in our research, contributing to a deeper understanding of nuclear fuel behavior under various irradiation conditions.

Acknowledgements:

References: [1] Doualle, T., Reymond, M., Pontillon, Y., & Gallais, L. (2021). Laser ablation of graphite with near infrared microsecond pulses. Applied Physics A, 127(9).