Laser micro-hole drilling of thin titanium foil and felt for proton exchange membrane water electrolyser application.

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Proton exchange membrane water electrolyser (PEMWE) plays a crucial role in renewable energy conversion and storage. The use of a thin membrane allows for a compact design and significantly facilitates mass transport. Porous transport media represent a key component in enhancing the efficiency of PEMWE via the effective mass transport of reactants and products during electrolysis [1,2].

Over the years, laser drilling has become a well-established production route due to high flexibility, no-tool wear, high repeatability, and minimal heat-affected zones. Lasers have become an ideal tool for microfabrication in PEMWE components. The demand for high throughput (~1000 holes/s) and high-quality array drilling of PEMWE components requires in-depth knowledge of the impact of laser processing parameters, scanning strategies, and operating conditions, especially when drilling thin foils for porous gas diffusion layers.

This study investigates laser ablation of 50 µm titanium foil and 300 µm titanium felt using a 50 W picosecond laser system. A series of experiments were undertaken to explore the influence of laser process parameters such as pulse frequency, number of pulses, fluence and drilling rate on the throughput, quality, and hole morphology. The study examines the impact of heat accumulation and the resulting thermal effects during drilling. The key objective of this study is to understand the interaction of multiple pulsed picosecond laser interaction with thin titanium foil and titanium felt during percussion drilling. The study presents an optimised process parameter, appropriate clamping system and processing environment for producing high throughput and high-quality holes at minimal thermal damage.

References: [1] J. Lee, "Accelerating bubble detachment in porous transport layers with patterned through pores," *Applied Energy Materials,* pp. 9676-9684, 2020.; [2] S. Kumar, "Hydrogen production by PEM water electrolysis - A review," *Materials Science for Energy Technologies,* vol. 2, pp. 442-454, 2019