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Pulsed Thermography for Quality Control of Internal Channels in Metal Additive Manufactured Fuel Cell Bipolar Plates

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Metal Additive Manufacturing (MAM) is emerging as a promising technology to produce fuel cell bipolar plates. Unlike traditional multi-layered plates, where ion-exchange pathways and cooling channels need to be assembled from multiple parts, MAM allows the creation of monolithic structures that integrate the H2 flow fields, structural features and thermal management channels into a single unit. This integration can significantly improve fuel cell performance by enhancing thermal homogenization, lowering ohmic resistance, while also decreasing manufacturing complexity, assembly time, and overall stack height for a given power output. However, the shift toward increasingly complex internal geometries introduces new quality-control challenges, particularly the risk of powder entrapment and partial or complete occlusions inside narrow cooling channels.

To ensure functional reliability and achieve industrial scalability, there is a strong need for robust non-destructive testing (NDT) methods capable of evaluating the internal integrity of thin Selective Laser Sintering-produced bipolar plates. In this context, pulsed active thermography has emerged as a promising technique due to its sensitivity to subsurface thermal discontinuities and its potential for high-throughput inspection.

This study investigates the capability of pulsed thermography to inspect internal channels with transversal section of 1–3 mm located at different depths in SLS-manufactured 4 mm thick bipolar plate. A systematic experimental design explores the effects of channel geometry, occlusion level, and thermographic parameters, as well as multiple post-processing algorithms. Custom-designed benchmark samples with controlled occlusions enable a quantitative evaluation of detection limits in terms of thermal contrast, signal-to-noise ratio (SNR), and spatial resolution.

The results aim to determine the minimum detectable channel size, the maximum depth at which features remain identifiable, and the ability of thermography to discriminate between clean and fully blocked channels. Ultimately, this work contributes to defining an optimized, industrially viable NDT workflow tailored for MAM bipolar plates. By enabling reliable inspection of integrated channel architectures, the proposed method supports the broader adoption of 3D-printed components for next-generation, high-efficiency fuel cell systems.

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