

**Architected materials for transpiration cooling:
application to combustion chambers**

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Abstract: In order to cool aero-engine combustion chambers as efficiently as possible, there is today a special interest given to transpiration cooling technology. The cooling air flows through a porous liner in which a large amount of heat can be exchanged by convection. The air injection could then take benefit of the pore distribution to form a more homogeneous protective boundary layer.

Partially sintered metallic materials are potential candidates to form these porous liners. The present work focuses on internal heat transfers. It aims to develop a methodology capable of highlighting the most adapted partially sintered architectures to this kind of application.

During transpiration cooling, flows and heat transfers are governed by some effective material properties which depends on the porous architecture: the effective solid phase thermal conductivity, the volumetric heat transfer coefficient and the permeability properties. Thanks to experimental works and numerical studies on samples digitized by X-ray tomography, simple relationships are first developed between the effective material properties of partially sintered materials and their architectural parameters. The porosity, the specific surface area and the powder type are selected to predict the effective properties.

These relationships are finally integrated into a heat transfer model predicting the thermal performance of a design at working engine conditions. A multi-objective optimization and an analysis of the optimal designs highlight some architectures as being potentially interesting for transpiration cooling.

Key-words: Transpiration cooling, Partially-sintered materials, X-ray tomography, 3D image based computing, Multi-objective optimization