PHD GRANT

Next step toward the miniaturisation of space cryocoolers

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An experimental and numerical study of Darcy – Weisbach friction factor and Nusselt number at moderate Reynolds numbers (1<Re<100) in a well-controlled microstructure for regenerators of pulse tube cryocoolers has been performed. The microstructure consists in convoluted channels of width 10, 20 or 40 µm and depth 150-300 µm, generated by rhombic- or sinusoidal-shaped staggered pillars (bottom of Fig. 1). The channels are etched in silicon wafers using the deep reactive ion etching of MEMS technology. The wall temperature is locally measured by thermometers lithographed on the Pyrex cap of the regenerator (top of Fig. 1).

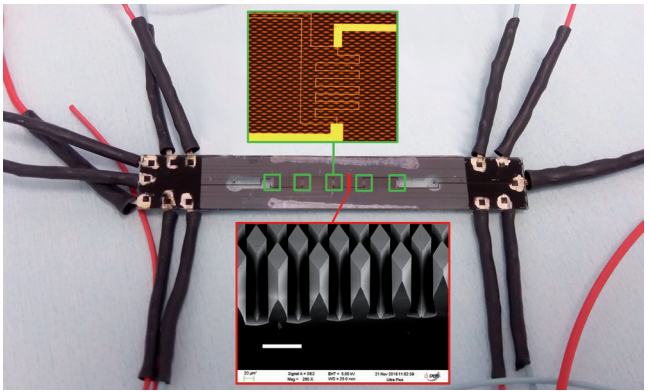

Fig. 1: Sample of micro-machined regenerator. Zoom on: thermometer (up) and bunch of micro-pillars (down), the scale bar is 100 µm.

The influence of the porosity, from 40 to 70%, and that of the geometry parameters have been studied. The possible integration of such passive modules in pulse-tube cryocoolers is also considered.

OUTCOMES

[1] Hydrodynamic Experimental and Numerical Study of Micro-Fabricated Regenerator, Proceedings of the 5th European Conference on Microfluidics, 85 (2018).

[2] A numerical and experimental study of pressure losses inside silicon microregenerators, in preparation.

Oral presentation: joined conference MicroFlu'18 NEGF'18, Strasbourg, France , 2018

Collaboration: Nanofab-Néel.

Leverage: reflexion about the technology readiness level of these products.