Microfluidic modeling of porous media by additive manufacturing

Marzia Quaglio

Center for Sustainable Future Technologies, Istituto Italiano di Tecnologia

Via Livorno, 60 - 10144 Torino (Italy)

Any material consisting of a solid matrix with an interconnected void volume, typically referred as pore volume, can be generally defined as a porous medium. In nature several systems can be found that can be classified as porous media, as beach sand, rocks, soils and several biological tissues, as bones and wood. Artificial porous media are used in several areas such as food technology, environmental engineering, biomedical and tissue engineering and chemical sciences. Pores are usually interconnected allowing the flow of one (single phase flow) or more (multi-phase flow) fluids through the material.

The analysis, characterization and understanding of fluid flow in porous media under a wide range of different thermodynamic, physical and chemical conditions is of great interest. Nonetheless fluid flow in porous media is quite complex to be investigated, first of all due to the opacity that usually characterizes porous material, and difficulties in controlled fluid injection and handling. Microfluidic-based models of porous media are emerging as potent tools to address this challenge. Indeed they provide the right platform to integrate transparent, interconnected porous networks that can be optically analyzed. In this scenario additive manufacturing is emerging as a leading technology to design and fabricate microfluidic micromodels to mimic the key features of porous media.

The possibility to characterize fluid motion in relevant porous models plays a crucial role to advance our ability to characterize and understand key physical phenomena governing fluid flow in porous media, such as fluid properties, solid-fluid and fluid-fluid interactions, phase trapping, wettability modification, giving access to a more mature understanding of several natural and industrial processes.