Direct numerical simulation of the turbulent flows in porous media with multiple length scales

Abstract

Many industrial flows, such as those in strip casting, and atmospheric flows, such as those occurring in forest canopy and around buildings in large cities, can be approximated as turbulent flows in porous media. Our recent studies indicate that the turbulent structures are generally limited by the pore scale, leading to the pore scale prevalence hypothesis (PSPH). However, the PSPH has a boundary of application: The PSPH will become invalid when the porosity approaches to 1. In the proposed project, we will investigate the application domain of the PSPH with direct numerical simulation methods. The test case is the turbulent flows in a generic porous matrix (GPM) with two length scales. Two DNS methods, a finite volume method (FVM) and a Lattice-Boltzmann method (LBM) will be used in the study to complement and verify each other. The length scales of the turbulent structures will be identified by instantaneous flowfield snapshots and determined by statistical results as well. The DNS results will be used for developing and validating a more efficient and accurate turbulence model.