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APPLICATION OF MULTI-SCALE TECHNIQUES TO PROBLEMS OF FLOW THROUGH POROUS MEDIA FOR PAPER-BASED MICROFLUIDICS

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Abstract. In this work, multi-scale techniques for the determination of the effective permeability (Darcy's law) of porous materials with paper-like microstructures are studied and applied. The multi-scale technique is based on the definition of a representative volume element (RVE) of the material to be modelled. In this case, the microstructure is built from connected channels where the fluid moves inside the void of the porous material (microscale). The fluid dynamic problem is solved under incompressible flow conditions in the Stokes regime, in order to calculate the effective permeability corresponding to that microstructure by imposing (*insertion*) pressure gradients on the microscale and subsequent numerical homogenization. This permeability is compared with experimental results for materials used in microfluidics such as Whatman paper #1 and Munktell, for which an appropriate sample size is sought in order to obtain a RVE. The technique is also validated by comparing the results obtained with DNS solutions (solution of the flow through the porous material on a single scale), with respect to solutions of the Darcy problem using the calculated effective permeability (numerical solution FE^2). The limits of application of this methodology and the modifications that should be made to the assumptions and formulations for appropriate flow modelling for paper-based microfluidic applications will be studied.