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Designing methods of microfluidic devices focused on non-Newtonian fluids

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Abstract

Industrial and scientific fields eager for intelligent applications that will assist them to increase the efficiency of their products and the accuracy of their results. Nature has always acted as a source of inspiration to technological developments, turning biomimetics into an increasingly active area of research. Additionally, the rapid development of computer power and computational methods allowed researchers to apply optimisation techniques in order to improve and perfect their designs.

In this paper, we describe designing methods based on biomimetic principles and optimisation procedures for creating intelligent microfluidic applications, appropriate for investigating flow and properties of non-Newtonian fluids. Initially, a novel biomimetic rule proposed[1] is presented for designing microfluidic bifurcating networks for power-law fluids, with specific and controlled fluidic characteristics. The applicability of the rule was investigated numerically by performing extensive CFD simulations and its limits were evaluated. Finally, inspired by the ability of contraction geometries to stretch the fluid in a strong extensional flow along the centreline[2] of the channel, we optimise a converging-diverging geometry to perform as an extensional micro-rheometer. Limitations of the design are reported in terms of Reynolds (Re) and Deborah (De) numbers.

References

[1] K. Zografos, R. W. Barber, D. R. Emerson, and M. S. N. Oliveira, "A novel design rule for constant depth microfluidic networks for power-law fluids." *Submitted to Microfluid Nanofluid*, 2015.

[2] D. F. James, G. M. Chandler, and S. J. Armour, "A converging channel rheometer for the measurment of extensional viscosity," *J Non-Newton Fluid Mech*, Vol. 35, 1990, pp. 421–443.