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# Identification of the mechanical properties of capsules using semi-automatic microfluidic method

X.-Y. Wang, A. Merlo, C. Dupont, A.-V. Salsac, D. Barthès-Biesel

## Introduction

Liquid core microcapsules are widely used in pharmacology, biotechnology to protect sensitive substances from the environment by means of a thin hyperelastic membrane. When subjected to an external flow, capsules undergo large deformation and the membrane may break. It is thus important to characterize the mechanical properties of microcapsule membranes to control the release of the internal fluid. For this purpose, we propose a microfluidic method based on an automatic inverse analysis of the deformed profiles of capsules flowing in a capillary tube to measure the elastic properties of a population of microcapsules.

## Methods

The three-dimensional dynamics of an initially spherical capsule flowing in a cylindrical channel, when its membrane is governed by a neo-Hookean (NH) or a general Hooke's law (GH) is solved by means of a fluid-structure interaction numerical model [1]. The capsule deformed profile and velocity are gathered in numerical databases, for different capsule-to-tube confinement ratios, relative flow strengths and material constitutive laws. The experimental deformed shape of a microcapsule flowing in a cylindrical tube is compared to those in the database. The best diffuse approximation fit, allows one to determine the unknown membrane shear modulus and the capsule size [2].

Another method consists of using microrheometry, where a capsule is subjected to a simple shear flow: the deformation is then directly linked to the flow strength for a given membrane constitutive law [3].

## Results

The two methods are used to characterize a suspension of artificial capsules with a cross-linked ovalbumin membrane. The membrane shear modulus predicted by the microfluidic method decreases with deformation for GH law. For a NH law, an approximately constant shear modulus  $0.043 \pm 0.004 \text{ N.m}^{-1}$  is obtained. The mechanical behaviour of the ovalbumin membrane can thus be modelled with the NH law. The average value of the shear modulus predicted by microrheometry is  $0.039 \pm 0.01 \text{ N.m}^{-1}$  for the NH law, which validates the microfluid method [4].

## Discussion

The microfluidic method is simple to implement and can be automatized for on-line measurements to characterize in real time the mechanical properties of a suspension of microcapsules with a 10% precision. It also allows one to determine the type of mechanical behaviour of a capsules wall, which is very important as capsules with a strain softening membrane may be prone to break-up though continuous elongation.

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