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Title:

Self-rolled polymer film: a route to microfluidic devices

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Abstract:

Self-enrolment is a well-known instability driven by stress inhomogeneity in thin film. Such folding of flat surfaces – which can be previously treated or patterned– into a tube present a great potential of application in microfluidics as the patterning of channel inner surfaces becomes of greater importance for a lot of practical aspects.
We investigate the case of PDMS-based bilayer. The instability is driven by PDMS swelling in solvent vapors. The second layer – responsible of the inhomogeneity - can be another harder material. We present two different cases where i- the hard layer is another thin film polymer deposited on the pdms and ii- the hard layer is made by the oxidation of the pdms layer itself. This last case is of main interest since it is the way used for soft-lithography. In Figure 1, we report the inner diameter of self-rolled films as a function of the total bilayer thickness: tubes as small as 25µm are achieved.

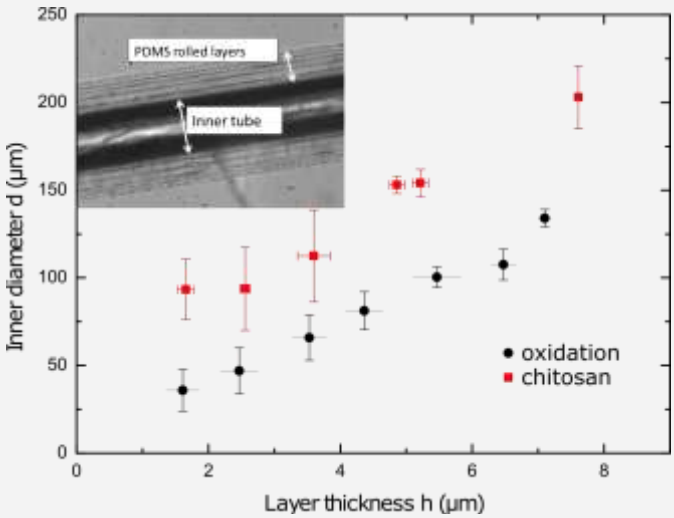

Figure 1. *Inner diameter vs total layer thickness for two different cap layers.*

In order to understand the rolling process, it is important to investigate the surface material mechanical properties of to-be-rolled bilayers. A canonical way to investigate thin films mechanical properties is AFM nanoindentation. Although it is of great importance in many fields –in particular in bio-cellular applications - the case of a thin hard film on a soft substrate is a difficult problem only partially solved. We present a new experimental method based on a recent indentation model of composite materials. We test our method on a bilayer of known chitosan thicknesses coated onto a thick pdms layer. The model is in good agreement with the expectations as shown in Figure 2.

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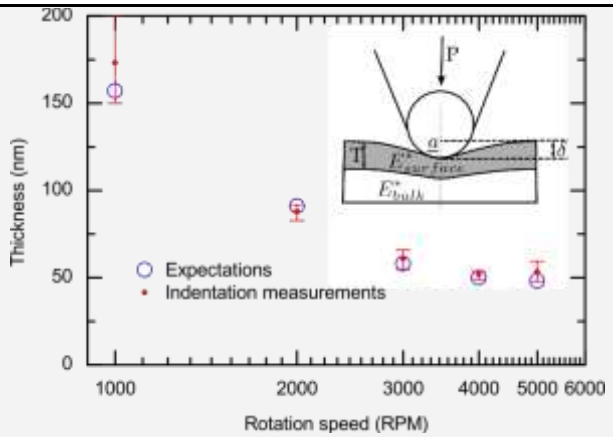

Figure 2. *Thicknesses measured with indentation models and expectations.* ***Inset.*** *Hertzian indentation of a bilayer.*