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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 $25\mu\text{m}$ are achieved.

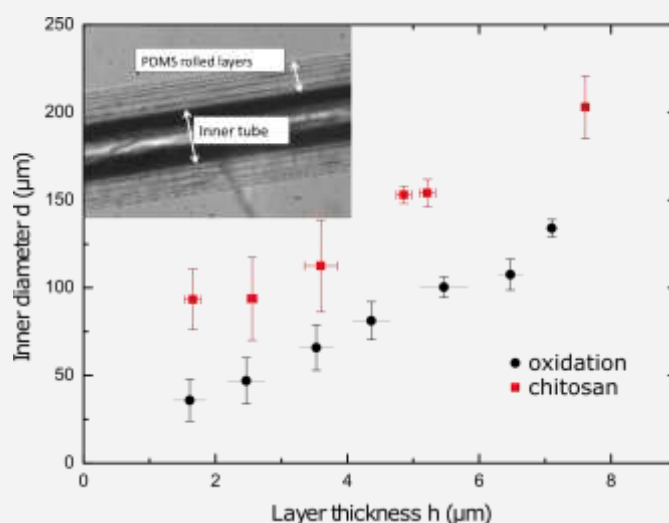


Figure 1. Inner diameter vs total layer thickness for two different cap layers.

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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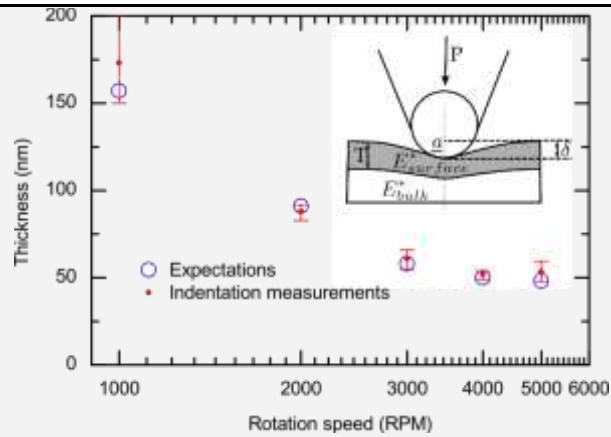


Figure 2. Thicknesses measured with indentation models and expectations. **Inset.** Hertzian indentation of a bilayer.