Séminaire LIONS
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Self-rolling of strained polymer bilayer films: a micromechanical phenomenon and a novel route to engineering of functional microcavities

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The talk is devoted to a remarkable micromechanics phenomenon observed for multilayer polymer films: self-rolling in selective solvents. The rolling is due to the bending moment, which arises because of the gradient of mechanical strain across the film, induced by unequal swelling of different layers of the film. For instance a bilayer consisting of the top polystyrene (PS) and bottom poly(4-vinyl pyridine) (P4VP) layers deposited on a solid substrate rolls up in an acidic or alcohol solution. Swelling of the P4VP solutions is opposed by the PS layer and results in curling of the film (Fig.1). The diameter of the arising polymer tubes can be controlled by thickness of the PS and P4VP layers, and varies between a few hundreds of nanometers and dozens of micrometers.

The phenomenon provides the possibility of complex engineering of the inner surface of microcapillaries. Before self-rolling, the future inner surface of a tube can be exposed to various procedures of surface functionalization like micro-contact printing, metal sputtering, photolithography, plasma treatment, etc. For example an electronic circuit can be photolithographically defined on the bilayer surface and rolled up producing magnetic micro-coils, or micro-scale heating elements. The engineered tubes can find advanced applications in many fields such as microfluidics, micro-electronics, micro-biology.

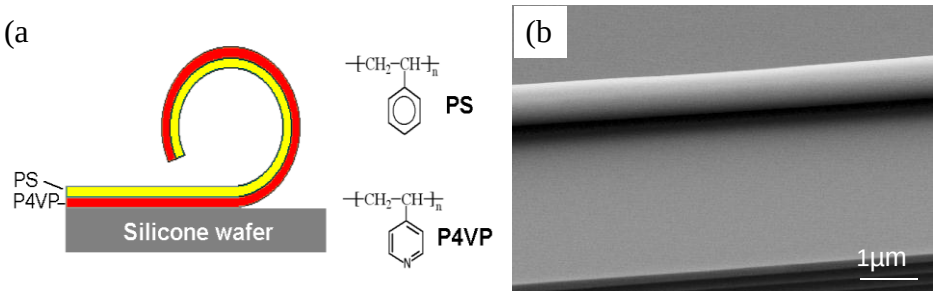

Fig.1 (a) Structure of a polymer bilayer which undergoes self-rolling in a water solution of an alcohol or an acid. (b) Scanning electron microscopy of a micron-wide tube.

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