Abstract:

Patterns and wrinkling on surfaces is ubiquitous in nature: from human skin to leaves, fruits and vegetables. Such patterns are also interesting for many modern technological applications, such as flexible electronics, optical gratings, microfluidic devices and lab-on-a-chip systems. However, the fabrication of these structures on very small scale (micro and nanometer scale) is a challenging task. Recently, a new technique has been developed, based on the release and bond back mechanism. The method consists of three steps: (i) the growth of a thin film with pre-stress on a substrate (ii) relax the film by reducing the interface strength (by electrolysis or chemical etching) and finally (iii) bond back, the bonding of the released film on the substrate due to the cohesive force of attraction between the film and the substrate. In this presentation, a theoretical investigation to study the formation of micro- and nanochannels based on the aforementioned release and bond back mechanism will be discusses. A new finite element method to study the process of delamination and bond back will be presented. Eventually the final channel dimensions and morphology of different systems is studied as a function of various system parameters such as film thickness, film size, elastic properties of the film and the cohesive energy between the film and the substrate. A dimensional analysis of the system of equations results in a set of dimensionless parameters which describes the entire process of channel formation in the form of master curves. The results show excellent agreement with the experimental channel morphologies, so that the results can be used as design tools for future channel systems.