Abstract:

Ultrathin polymer films (<100 nm) are prone to spontaneous instability and subsequent morphological evolution which result in isotropic meso scale structures. Such instabilities have both useful and adverse effects. On one side, instability mediated patterning has the potential to become a viable non lithographic surface patterning technique. On the other hand, such instabilities are completely undesirable from the stand point of coatings. In this thesis we have looked in to certain critical and unresolved issues related to both these aspects.

Instability induced patterns are often random and isotropic, and therefore find limited practical application as compared to regular meso patterns fabricated by Soft Lithography based techniques, which find wide application in various areas such as organic electronics, self cleaning surfaces, nano biotechnology applications, structural color etc. Thus, it is important to impose order to the instability mediated patterns, if they are to be used as viable alternative to lithographically fabricated patterns. This is often achieved by dewetting on a topographically patterned substrate. We investigate the influence of substrate feature height on pattern directed dewetting, which is an important unresolved issue (chapter 4). In order to do the experiments, it becomes necessary to have substrates with different feature height but with same periodicity. To produce these substrates we came up with a novel soft lithography method by which patterns of different feature height can be produced using a single stamp (chapter 2). We have also quantified the morphology of an as coated polymer film on a topographically patterned substrate and found out that the substrate wettability strongly influences the morphology of the film (chapter 3), which in turn influences the dewetting pathway. We have also extended our experiments with pattern directed dewetting for a polymer bilayer, and obtained novel embedded structures (chapter 5).

We have also looked in to issue of imparting stability to an ultra thin polymer film by addition of $\mathbf{C_{60}}$ fullerene nano particles (Chapter 6). Our experiments show for the first time that the suppression of dewetting is also influenced by the relative magnitudes of the surface energy of the particle and the substrate, in addition to the well known entropic interactions.

Keywords: ***soft lithography, dewetting, wettability, bilayer, C_{60} fullerene***