Abstract

Spontaneous instability mediated rupture of thin polymer films (thinner than 100 nm), is a ubiquitous phenomenon that results in rupture and subsequent dewetting of the films. Such instability arises due to attractive van der Waal's forces between the interfaces of the film. While this phenomenon is utilized to create meso scale structures, thin film dewetting is undesirable from the standpoint of coating applications. In this context, several strategies have emerged over the recent years, out of which the most simple and effective approach is the addition of nanoparticles above a critical concentration. Typically, such polymer thin films are casted on a substrate by spin coating technique and dewetting is engendered by thermally annealing of the films (TA) to a temperature above glass transition temperature or exposing the films to solvent vapors (SVE). This thesis reports various fundamental aspects related to the morphology and stabilization of single and multi-component thin polymer films. While spin coating of polymer solution is known to lead to formation of continuous films, we report a phenomenon known as spin dewetting, where extremely dilute polymer solution ruptures and dewets during spin coating. Further, we show spin dewetting can be suppressed by the addition of nanoparticles in the polymer solution (Chapter 2). As dewetting is commonly engendered in films following TA and SVE routes, we show how dewetting route influences the final dewetted features and the dewetting dynamics for both particle-free as well as particle-containing thin polymer films. Additionally, the presence of nanoparticles, in trace amount, is observed to modulate the dewetted morphology of particle-containing polymer thin films (Chapter 3). As stable polymer thin films with multiple functionalities find several applications in optical devices and coating industries, we have investigated the stabilization of multi-component thin polymer films, particularly of polymer bilayer thin films and polymer blend thin films, by addition of nanoparticles. We show that stabilization of the layer in a polymer bilayer thin film coated on a non-wettable substrate is possible when nanoparticles, above a critical concentration, is added to the top layer only (Chapter 4). Next, we report the modulation of phase segregated morphology in an immiscible polymer blend thin film with increase in concentration of nanoparticles, for different film thickness and composition (Chapter 5). Extending this study, we further investigate the morphological evolution of particle-containing blend thin films subjected to thermal annealing above its glass transition temperature, for a particular blend composition (Chapter 6).