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Wrinkled interfaces: Taking advantage of surface instabilities to pattern polymer surfaces

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ABSTRACT

The generation of nano-microstructured polymer film surfaces has been a challenge during the last decades. Advances in the fabrication of structured polymer surfaces to obtain micro and nano patterns have been accomplished following two different approaches, i.e., by adapting techniques, such as molding (embossing) or nano/microimprinting or by developing novel techniques including laser ablation, soft lithography or laser scanning among others. Thus, higher resolution capabilities are directly related with technological advances. In contrast to the use of highly sophisticated tools required by the above mentioned techniques, surface instabilities produced by different mechanisms take advantage of the inherent properties of polymers to induce particular surface patterns. Some of the surface instabilities are well known since decades but novel and old known instability mechanisms have been only recently extended their use to pattern polymer surfaces. This recent interest relies on the rich and complex patterns obtained as a result of self-organizing processes that are rather difficult if not impossible to fabricate by using traditional patterning techniques.

Among the approaches to obtain patterned interfaces by means of surface instabilities the formation of wrinkles is the most explored method and will be the center of this review. The fabrication approaches employed to induce wrinkle formation and the possibilities to fine tune the amplitude and period of the wrinkles, the functionality and their final morphology are thoroughly described. Finally, an overview about the main applications in which buckled interfaces have been already employed or may have an impact in the near future is provided. Their use as templates, as flexible electronics, as supports with controlled wettability and/or adhesion or for biorelated applications are few of the fields in which the unique characteristics of wrinkled interfaces play distinguishing role.

Contents

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1. Introduction

The generation of nano-microstructured polymer film surfaces has been a challenge during the last decades justified by the large amount of applications that derive from them. Patterning of thin polymer films is required for applications ranging from the fabrication of microchips and microelectromechanical (MEM) devices [1,2] to the preparation of substrates for cell growth [3,4] and adhesion [5] just to mention few of them.

The advances in the fabrication of structured surfaces to obtain micro and nano patterns have been accomplished by two parallel routes: adapting techniques, such as molding (embossing) [6–11] or nano/microimprinting [12–15] and/or by developing novel techniques including laser ablation [16], soft lithography [17–19] or laser scanning [20]. Thus, technological advances provided scientists of sophisticated fabrication tools with higher resolution capabilities.

In contrast to the use of highly sophisticated tools required by the above mentioned techniques, surface instabilities take advantage of the inherent properties of polymers to induce particular surface patterns. Surface instabilities are either spontaneously produced at the small-scale in highly confined systems that are usually unstable or can be induced in stable films applying

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