Preface

The traditional micro/nanofabrication techniques based on photolithography are intrinsically expensive, time-consuming, effective to only a limited set of photoresists, and not directly applicable to nonplanar surfaces. Among the conceptually new strategies that offer possible routes to both small features and low costs, self-assembly involving thin sheets, films, and multilayers has become the new cornerstone. In self-assembly, small-scale objects spontaneously organize and aggregate into stable, well-defined structures, which are guided by the characteristics (e.g. surface, electrical, and mechanical functionalities) of the subunits, and the final structures are reached by equilibrating to the form of the lowest free energy. The design of components that organize themselves into desired patterns and functions is the key to applications of self-assembly. In addition, self-assembly can be used with soft lithography and/or controlled deposition to transfer and create complex features in various small material systems.

Typical molecular self-assembly involves noncovalent interactions, such as electrostatic, van der Waals, and hydrogen bonds. To assemble larger components beyond the molecular level, physical forces including magnetic, capillary, dispersion, and entropic interactions are also involved. Presented in this book is a novel category of self-assembly driven by mechanical forces: Mechanical Self-Assembly, where controlled mechanical buckling is shown to be able to self-assemble ordered patterns in thin films.

Traditionally, buckling and buckle delamination are among the most frequently encountered failure modes in thin films. While a significant amount of efforts have been put together to understand the failure mechanisms and to improve the reliability of thin film systems, through mechanical self-assembly, they can become useful and underpin a new fabrication technique. From a practical point of view, mechanical self-assembly is complementary to, and sometimes offers advantages over, the conventional physical and chemical self-assembly processes. From a fundamental point of view, it also provides a rich opportunity to extend our understanding of the mechanics in thin films.

Mechanical self-assembly is arguably one of the cheapest, quickest, and simplest techniques for manufacturing and patterning structures at the micron and submicron scales; it works with most common thin film materials, offers various selections of patterns, and directly applicable to planar and nonplanar surfaces. The subject of mechanical self-assembly is a wide open area with numerous exciting potentials in engineering and biology remain to be explored.

The book collects a number of recent advances in the area of mechanical self-assembly, including fundamental wrinkling and delamination mechanics, experimental techniques, applications to fabrication and morphogenesis. Chapter 1 presents an overview of mechanical self-assembly in nature and engineering. Chapter 2 discusses the spontaneous patterns formed by growth of biological systems. Theory of shaping by growth is given in Chap. 3. Chapter 4 illustrates experimental thin film wrinkle morphologies. Relevant theoretical background is given in Chap. 5. In Chap. 6, the surface crease phenomena are discussed. Chapters 7 and 8 present delamination buckling/channels self-assembled in thin films. Finally, Chap. 9 extends spontaneous buckles on curved substrates.

New York, NY, USA Xi Chen

http://www.springer.com/978-1-4614-4561-6

Mechanical Self-Assembly
Science and Applications
Chen, X. (Ed.)
2013, X, 206 p., Hardcover
ISBN: 978-1-4614-4561-6