Nanoscale pattern formation: an interplay between hard and soft condensed matter physics

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The study of pattern formation - namely, the emergence of a regular structure from a homogeneous medium which is perturbed by an external agent driving it out of equilibrium - has its roots in (macroscopic) contexts traditionally regarded as instances of soft condensed matter, such as fluids, chemical reactions, and even biological systems. However, the advent of high-resolution analytical and observation techniques has allowed to elucidate the occurrence of quite similar phenomena also in the context of traditional hard (solid state, microscopic) condensed matter systems. This fact has basic implications in terms of the relative economy of principles that seems to govern the self-organization of matter. Within Nanoscience and Nanotechnology, it also has some potential for the production of materials with new or enhanced properties, or through more efficient techniques.

This talk will attempt a brief overview on the interplay between hard and soft condensed matter physics with respect to the formation of nanoscale-sized patterns. Given their relevance at microscopic scales, we will specifically address the nanopatterning of solid surfaces, through techniques like e.g. ion-beam sputtering or other. By considering specific examples from seemingly disparate systems like colloidal mixtures, thin fluid films, or granular media, we will illustrate the experimental occurrence within the realm of hard condensed matter, of behaviors which are usually expected in e.g. soft matter, and vice versa. Consequently, a fruitful exchange of concepts and ideas between these two domains of condensed matter physics can be pursued that helps advance our general understanding of pattern formation at large, and potentially enlarge the variety and usefulness of surface nanopatterns that can be achieved in practice.