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Ion-induced surface patterning and its application in nanofabrication via templated growth

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Low-energy ion irradiation of surfaces can lead to nanoscale pattern formation with a wide variety of morphologies, resulting from a number of interacting ballistic and diffusive mechanisms which govern the mass redistribution under ion irradiation. The choice of process parameters such as sample temperature or ion incidence angle determines the relative influence of these mechanisms and thereby the pattern morphology. After briefly outlining the patterning mechanisms and discussing the resulting morphologies on semiconductor surfaces, we present our approaches at templated nanostructure growth based on these ion-induced surface patterns. They include epitaxial nanowires via geometric shading, long-range chemical ordering in diblock-copolymer thin films, and engineering of magnetic anisotropy in topographically modulated thin films.
The required technologies of low-energy ion irradiation, polymer chemistry, and physical vapor deposition are well-established and can readily be implemented at industrially relevant scales. Thus, nanostructured materials fabricated in such bottom-up manner have the potential to make substantial contributions to solving our society's present challenges: They can increase the sensitivity of diagnostical tools in medicine, lead to novel information technology, or enhance the efficiency of energy harvesting from renewable sources.

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