

## **“Phase nanoengineering” via thermal scanning probe lithography**

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Searching for new methodologies and techniques for tailoring the physical properties of materials at the nanoscale is of crucial importance both for the discovery of new phenomena, and for harnessing their potential in applications. Here, we discuss the direct control of the physical properties of condensed matter systems using highly localized heating from a nanoscopic probe, for producing controlled phase changes, which in turn lead to finely tunable properties.

In particular, we focus on the reversible patterning of “spin textures” in ferromagnetic materials, achieved via thermally assisted magnetic scanning probe lithography (tam-SPL). Then, we show that tam-SPL written spin textures can be used effectively for controlling the emission, propagation and confinement of spin waves in magnonic devices.

Finally, we give an overview of future applications of phase nanoengineering in other contexts and systems. The direct, tunable nanoscale control of the physical properties of matter, with a focus on the implementation of new functionalities which are not achievable with conventional nanofabrication techniques, opens up several possibilities for the investigation and application of new phenomena.