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Scanning Probe Lithography and Laser-Assisted Direct Nano-Relief Engineering

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Scanning Probe Lithography (SPL) is a versatile technique for prototyping planar nanostructures with simultaneous in situ characterization. Using a nanoscale tip, surfaces can be mechanically or electrically modified to create predefined patterns, either through direct modification or thin resist layer masks. Additionally, interference and plasmon lithography allow for the efficient generation of nanoscale patterns under SPM control. Our approach has proven effective in fabricating molecular electronic device elements, including arrays of subnanometer threads and plasmon waveguides constructed from elastic linkers and gold nanocylinders. Furthermore, multilayer graphene flakes were precisely perforated, cut, and engraved using SPL.

In GeSn alloys, we achieved local electronic property modification by applying electric fields between the tip and the surface. The resulting variations in electronic work function and resistivity were linked to increased Sn content in the near-surface regions of the patterns created by the SPM tip.

We also investigated the kinetics of surface relief grating (SRG) formation in amorphous AsSe thin films. SRGs were induced using holographic recording with near-bandgap light and further enhanced with interference patterns. The growth kinetics were found to depend on film composition and light polarization. Subwavelength reliefs formed on the AsSe surface through interaction with an underlying gold pattern, leveraging localized near-field effects from surface plasmon resonance.

These findings demonstrate the potential of SPL and laser-assisted techniques for advanced nano-engineering and material property tuning at the nanoscale.

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