The work by Lin et al. provides a glimpse of what might be possible with the help of opto-thermal effects and OTENT. A designed temperature landscape to tailor local electric fields, no longer bound by wires and electrodes, may be a versatile tool for separation, aggregation, confinement and manipulation of not only plasmonic building blocks but many other charged nano-objects. While there is still some way to go before understanding all effects contributing to OTENT on the same level as the well-studied conventional optical tweezers, the complexity of thermal non-equilibrium effects at interfaces will certainly reveal even more useful surprises for a 'hot' future for manipulation and trapping. ❐

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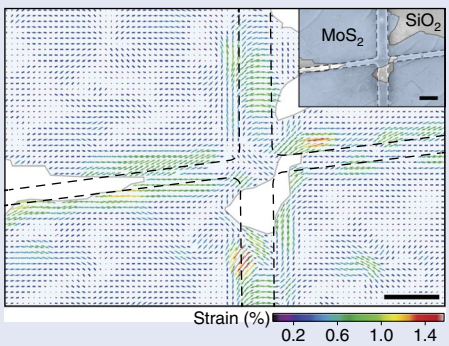
2D MATERIALS

High-resolution strain imaging

The use of strain is a well-known and popular method to tune the optoelectronic and electronic properties of semiconductor materials. For example, strain can transform indirect-bandgap semiconductors into direct-bandgap materials with strongly enhanced radiative efficiency and can also modify the electronic band structure of semiconductors such that excitons can be funnelled into a small region to form exciton condensates. However, to more fully understand the impact of strain on the properties of semiconductors, especially 2D materials, a technique for performing high-resolution, non-invasive strain imaging is required.

Now, Lukas Mennel and co-workers from Vienna University of Technology have done just that, developing a strain probing technique with submicrometre resolution based on second-harmonic generation (SHG) (*Nat. Commun.* **9**, 516; 2018). The researchers demonstrated the capability of their scheme by obtaining strain maps of MoS_2 monolayer flakes on lithographically defined structures (as pictured; scale bars, 1 µm).

For the proof-of-principle experiment, the Austrian researchers chose a monolayer of MoS_2 because it can withstand a high level of strain of >10%. To begin with, a flake of MoS_2 was mechanically exfoliated and transferred onto a flexible substrate. The photoelastic tensors of the sample were then determined by applying different levels of uniaxial strain using a two-point bending method, and measuring the polarization-resolved SHG signal.



As MoS_2 monolayers have a trigonal prismatic D_{3h} lattice symmetry, the 2D photoelastic tensor has 12 non-zero elements, with only two independent components, which can be determined by fitting the SHG intensity at different known strain levels. Experimentally, it was found that the two independent components were connected by a linear relation. This relation simplifies the nonlinear fitting procedure, and allows the measured polarization-resolved SHG data from strained MoS_2 monolayers to be fitted accurately. Having extracted these parameters, the researchers employed SHG spectroscopy to locally probe inhomogeneous strain fields in MoS_2 monolayer samples.

To make the SHG measurements, pulses from a Ti:sapphire laser source (pulse duration of 200 fs, repetition frequency of 76 MHz) were sent to the samples through a 100× confocal objective lens (numerical aperture of 0.9). The wavelength was tuned to 800 nm, below the MoS_2 bandgap.

Using a pick-and-place technique, a mechanically exfoliated MoS_2 monolayer flake was transferred onto a 115-nm-high lithographically defined structure on a Si/SiO_2 substrate (pictured, inset). The force applied during the transfer technique caused the MoS_2 to be strained by the non-flat surface. The resulting local uniaxial strains were plotted as vectors (pictured). Contaminations on the substrate also led to strained MoS_2 areas (lower right corner). The spatial resolution of the strain imaging was 280 nm. ❐

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