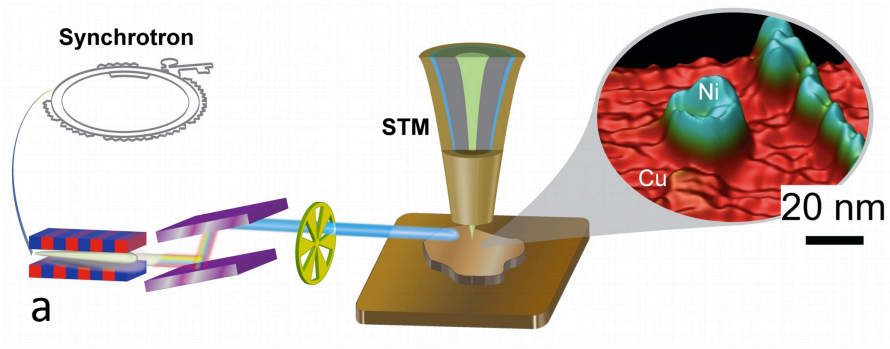
Elemental fingerprinting of materials with sensitivity at the atomic limit



Topography

Chemical contrast before Ni edge

Chemical contrast after Ni edge

Combining STM and X-rays. a, Experimental setup. **b,** 3-D view of STM topography (110 × 60 nm^2). **c,** The sample current does not provide chemical contrast, when the X-ray energy (E = 8.25 keV) is below the Ni K-edge (8.33 keV). **d,** The Ni island on the Cu(111) terrace and islands along the Cu step edge become clearly visible for photon energies above the Ni K-edge, here E = 8.55 keV.

N. Shirato, M. Cummings, H. Kersell, Y. Li, B. Stripe, D. Rosenmann, S.-W. Hla & V. Rose, Nano Letters 14, 6499-6504 (2014).

Scientific Achievement

SX-STM Technique simultaneously resolves the chemical characterization and topography of nanoscale materials down to single atom height sensitivity. The technique combines synchrotron x-rays (SX) and scanning tunneling microscopy (STM). Individual nickel clusters on a copper surface were identified and resolved; photo-ionization cross-sections were measured by varying the photon energy.

Significance and Impact

Imaging with direct chemical sensitivity has been a long-standing goal since STMs were developed, and this research allowed observation of elemental contrast at 2 nm lateral resolution and just one atomic layer in height. This will impact materials science, electronics, and even biology.

Research Details

- SX are used as a probe and a nanofabricated smart tip of an STM is used as a detector.
- Smart tips were developed at Argonne (U.S Patent 2014/0259235).
- Utilized APS/CNM beamline ID-26.

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