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Alignment method simplifies single-molecule analysis

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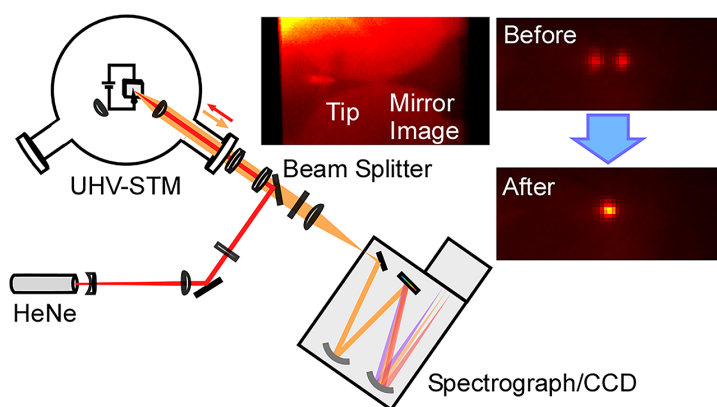


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Straightforward method combines scanning tunneling microscope with optical spectroscopy



When combined with scanning tunneling microscope (STM), optical spectroscopy can be used to analyze materials at the single molecule level. However, this technique requires optical alignments with at least micrometer-level precision, hindering its widespread adoption. Aiga and Takeuchi established intuitive and straightforward procedures to align, from scratch, the optical setup for STM-based spectroscopy performed in an ultrahigh vacuum chamber.

The authors found that monitoring the STM's metal tip through a spectrograph set to zeroth order diffraction enables users to visualize it and thus optimize the alignment of incoming light. Detecting the STM-luminescence as a reference in the same image frame as the metal tip enabled *in situ* mapping of the exact position of the STM's tunneling gap and introduction of the excitation light there. As optical alignment improved, the team observed two reflected spots merging in the image.

They achieved even better spatial overlap between the tunneling gap, of only nanometer scale, and micrometer-sized incoming beam spot by monitoring a low-frequency, plasmon-enhanced inelastic scattering signal.

“Our method allows one to overcome the alignment difficulties associated with STM-based optical experiments performed in an ultrahigh vacuum chamber, where only limited view and access to the setup are available,” author Satoshi Takeuchi said. “Our scheme facilitates the light-combined STM study more readily than conventional methods.”

The researchers plan to apply their technique to tip-enhanced nonlinear spectroscopy experiments.

“This is expected to accelerate the quest at the single molecular level for the underlying mechanism of physicochemical properties of each individual adsorbate,” Takeuchi said.

Source: “A straightforward optical alignment protocol for STM-based single molecule spectroscopy,” by Norihiro Aiga and Satoshi Takeuchi, *Applied Physics Letters* (2022). The article can be accessed at <https://doi.org/10.1063/5.0107414>.

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