

Spatial mapping of carbon nanotubes using a customized attoCFM I

The highly modular and flexible cryogenic confocal microscope attoCFM I features a fully adjustable excitation and collection port enabling easy handling and filtering of the excitation and collection signal for Raman spectroscopy. It furthermore incorporates the ANPxyz100/LT stages which are specified to work at low temperatures and enable lateral positioning over areas as big as 6 x 6 mm and accurately adjusting the sample in the focal point.

In the application shown here, the principle of confocal microscopy is applied to spatially map a single carbon nanotube (CNT) by detecting its Raman signature. An excitation laser at 745 nm is focused onto a carbon nanotube sample, which has been primarily prepared by growing CNTs on a Si/SiO₂ substrate via chemical vapor deposition. The evolving Raman signals have been recorded showing a sharp characteristic G-band line at approx. 1600 cm⁻¹ (Fig. 1).

In order to achieve spatial mapping of the CNT, the slip-stick positioning xy-stage ANPxyz100 is used as a step-by-step scanning device. Scanning confocal Raman images with sizes of 18 x 18 μm were taken in reflectivity. The recorded spectral data corresponded well with the nanotubes observed in the AFM mode.

Furthermore, the orientation of CNT was investigated by measuring the polarization intensity signal of the Raman spectrum. Figure 3 shows that a different G-band intensity is recorded for various states of polarization. For instance, 0° polarization yields the strongest signal which corresponds to the fact that the laser light is polarized along the nanotube axis.

In conclusion it can be stated that the high-resolution attoCFM I microscopy system represents a comprehensive and easy-to-use examination method for carbon nanotubes. Ongoing research will establish these measurements at cryogenic temperatures around 4 K.



The attoCFM I beam splitter head.

Reference:

(1) The data was generously provided by Dr. A. Högele from the Quantum Photonics Group of Prof. Dr. A. Imamoglu, ETH Zürich, Switzerland.

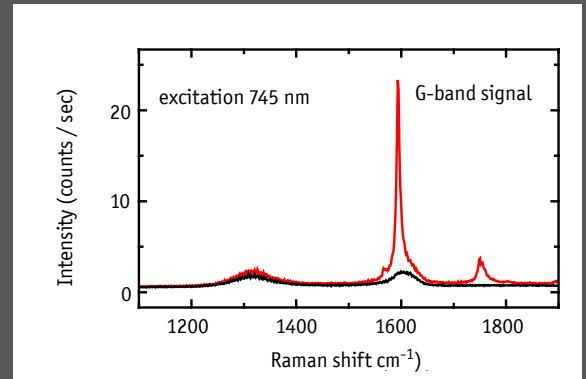


Fig. 1: Carbon nanotube Raman signature; excitation laser @ 745 nm, Laser power: 2.5 mW; background Raman signal (black line), carbon nanotube induced Raman signal (red line).

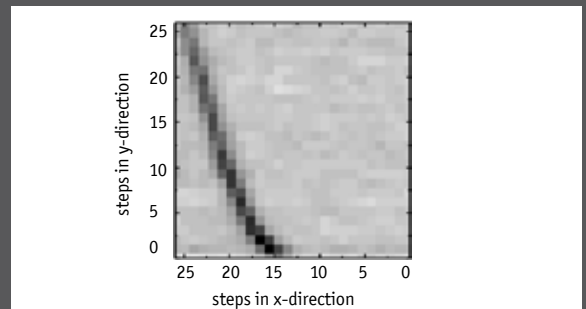


Fig. 2: Step scanning and mapping of the carbon nanotube using the integrated G-band signal; step size = ~700 nm.

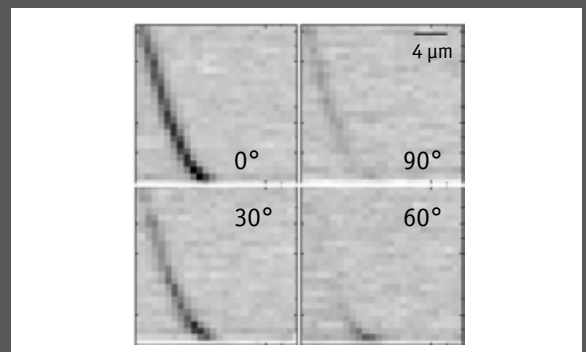


Fig. 3: Polarization-sensitive map of a single carbon nanotube using the integrated G-band signal.

RELATED PRODUCTS

attoCFM I	highly modular and flexible confocal microscope
ANPxyz100/LT	linear, horizontal stepper positioner for 2" setups & big loads
ANC150/3	electronic controller