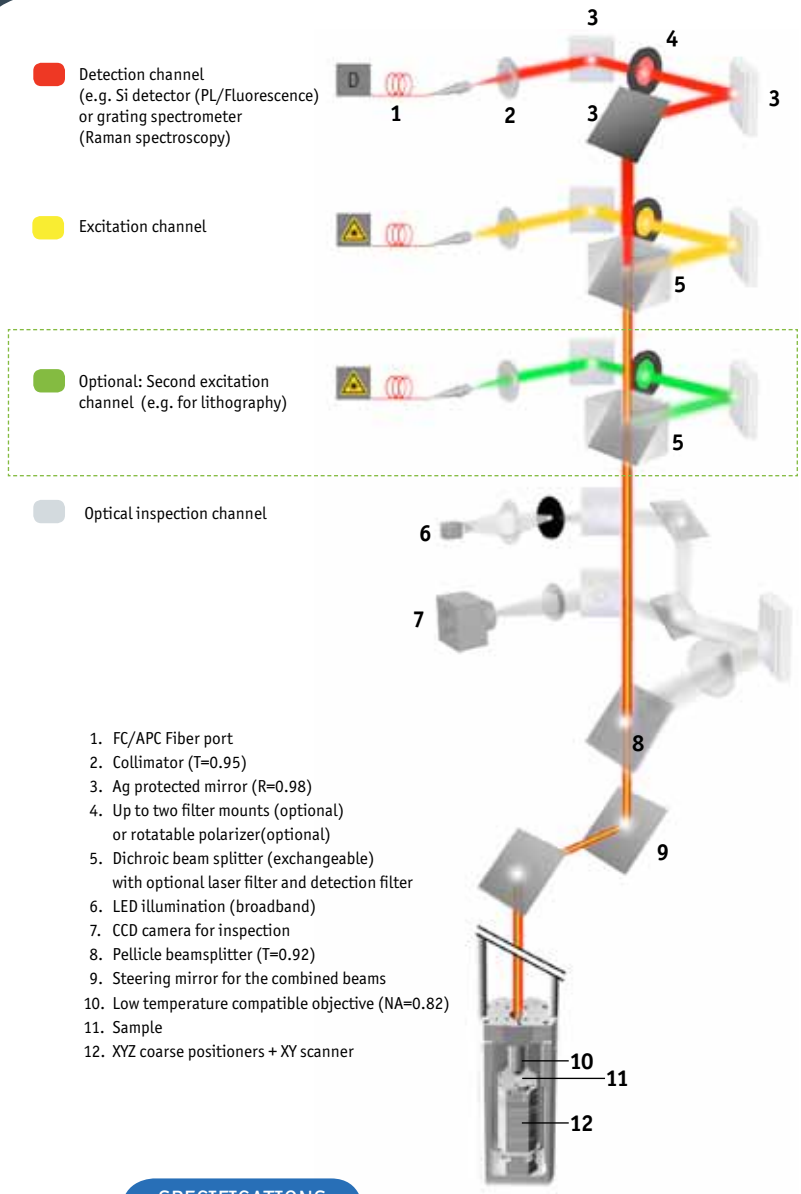
attoCFM

STABLE. MODULAR. EASY TO USE.

THE ALL-NEW OPTICAL HEAD FROM THE PIONEERS OF CRYOGENIC CFM

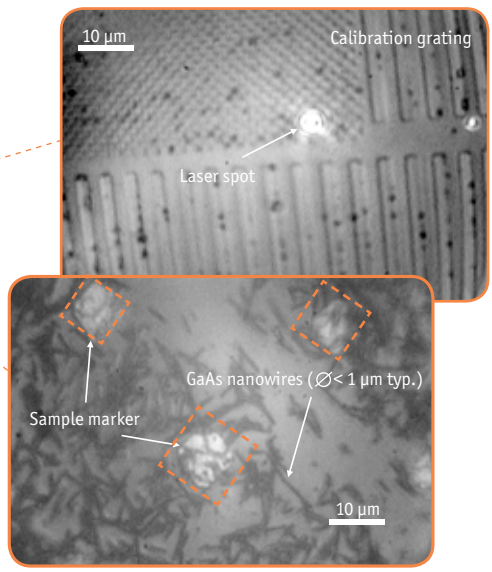
SYSTEM SCHEMATICS



1. FC/APC Fiber port
2. Collimator (T=0.95)
3. Ag protected mirror (R=0.98)
4. Up to two filter mounts (optional) or rotatable polarizer(optional)
5. Dichroic beam splitter (exchangeable) with optional laser filter and detection filter
6. LED illumination (broadband)
7. CCD camera for inspection
8. Pellicle beamsplitter (T=0.92)
9. Steering mirror for the combined beams
10. Low temperature compatible objective (NA=0.82)
11. Sample
12. XYZ coarse positioners + XY scanner

SPECIFICATIONS

Confocal unit	Configuration	Compact and modular design, up to three optical channels standard configuration: 1 excitation channel, 1 detection channel
	Key benefits	Quick and reliable alignment of each channel, steering mirror for the combined beams exceptional long-term stability
	Quick-exchange of optical components	Beamsplitters, filter mounts for up to 4filters / polarizers (1" diameter), optional piezoelectric rotator with filter mount
	LT-compatible objective	Achromat, NA = 0.82, WD = 0.4 mm, confocal resolution ~550 nm (@635 nm in reflection)
	Inspection unit	Sample imaging with large field of view: ~75 µm (attoDRY), ~56 µm (attoLIQUID)
Sample positioning	Coarse range	5 mm x 5 mm x 5 mm
	Step size	0.05 .. 3 µm @ 300 k, 10 .. 500 nm @ 4 k
	Scan range	50 µm x 50 µm @ 300 K, 30 µm x 30 µm @ 4 K
Illumination	Excitation wavelength range	632 nm, others on request
	Port specification	FC/APC-connector for single mode fibers
Detection	Detection mode	e.g. reflection, luminescence, fluorescence, Raman (optional)...
	Detection wavelength	Detector upon user's choice, typically Si detector, coupling of the light to other detectors possible, e.g. spectrometer, APD, ...
	Port specification	FC/APC-connector for single mode fibers (other types on request)
	Pinhole size	Depending on fibers, typically 3 .. 9 µm mode field diameter
	Options	Low temperature compatible detector below the sample for transmission

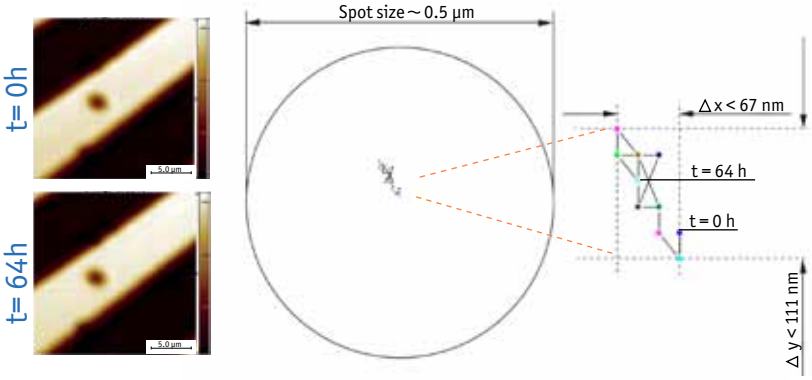


attoCFM

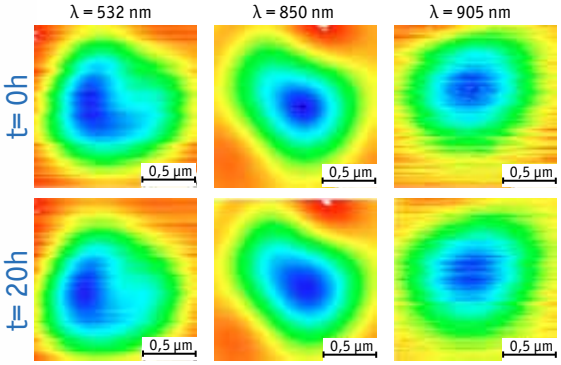
LOW TEMPERATURE CONFOCAL MICROSCOPY REDEFINED.

THE ALL-NEW OPTICAL HEAD FROM THE PIONEERS OF CRYOGENIC CFM

REMARKABLE LONG-TERM STABILITY

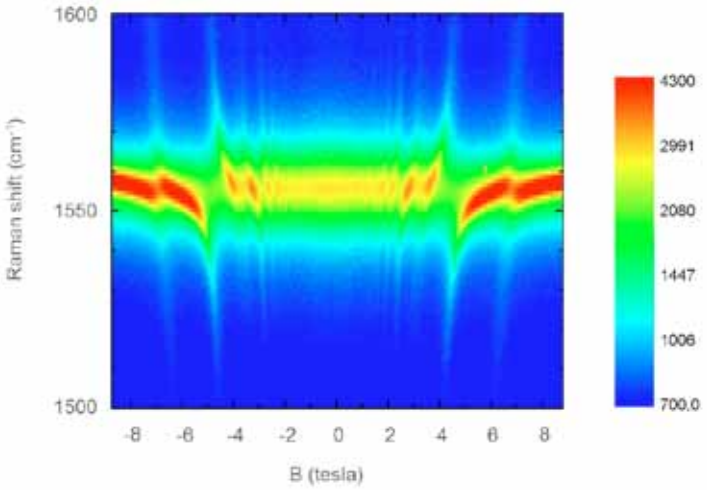


Long term drift measurement over 64 hours at 4 K using the standard configuration with two channels. The spot size is on the order of 0.5 µm, while the center position of the spot drifts by less than 1.5 nm / hour on average.



Long term drift measurements recorded on a single quantum object at 4 K using all three channels of the attoCFM.

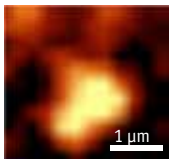
SELECTED APPLICATIONS I: CRYOGENIC RAMAN MICRO-SPECTROSCOPY ON GRAPHENE



The figure to the left shows magneto-Raman measurements recorded at 4 K on an exfoliated single crystal of natural graphite with unprecedented spatial resolution (approx. 0.5 µm), while sweeping the magnetic field from -9 T to + 9 T. The data were recorded on a single graphene flake and demonstrate the crossing of the E2g phonon energy with the electron-hole separation between the valence and conduction Landau levels (-N,+M) of the Dirac cone. Resonant hybridization of the E2g phonon is a specific signature of graphene flakes* which display very rich Raman scattering spectra varying strongly as a function of magnetic field.

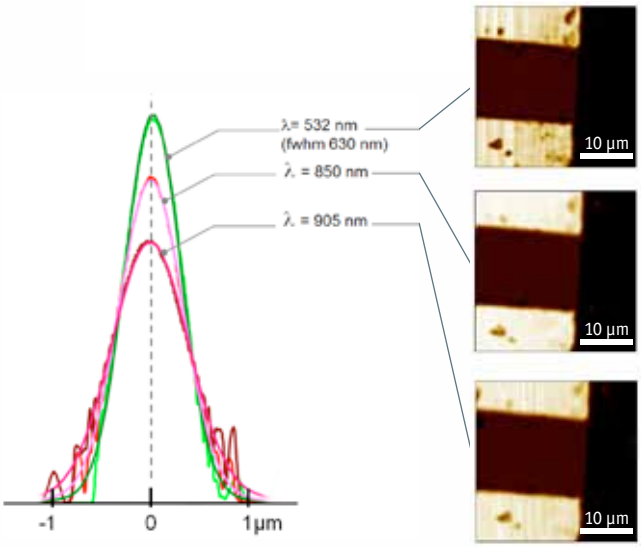
(attocube application labs 2011, work in cooperation with C. Faugeras, P. Kossacki and M. Potemski (LNCM I - Grenoble, CNRS_UJF_UPS_INSA France))

*C. Faugeras et al., Phys. Rev. Lett. 103, 186803 (2009)



graphene flake on natural graphite

SELECTED APPLICATIONS II: LOW TEMPERATURE PHOTOLITHOGRAPHY ON SELF-ASSEMBLED QUANTUM DOTS



Highly sophisticated new techniques in device fabrication have greatly benefitted from the possibility of *cryogenic in-situ optical lithography*: while monitoring the luminescence signal of e.g. single self-assembled quantum dots with one colour, an appropriate photoresist is exposed *in-situ* using another colour. This serves the purpose to define microcavities around those single quantum objects, a technique pioneered by the French group around Dr. Pascale Senellart at the LPN (CNRS) [1-3]. Based on the same principles, the new attoCFM in combination with an optional , sophisticated closed-loop control system allows users to determine (and relocate) the position of e.g. quantum dots *in-situ* with a repeatability better than 10 nm. The figure to the left shows a superposition of the focused spots of three CFM channels at 4 K with the following key features:

- Spots alignment resolution ±15 nm
- Absolute positioning (contouring) error: 12 nm @ 1 µm/s
- Long term drift less than 10 nm/h

[1] Dousse et al., PRL101, 267404 (2008)
[2] Dousse et al., APL94, 121102 (2009)
[3] Loo et al., APL 97, 241110 (2010)

attocube systems
explore your nanoworld