Development of Automated Opto-Thermal Characterization System

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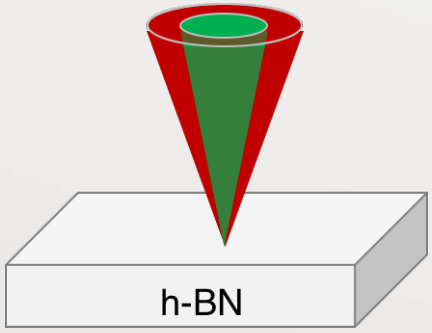
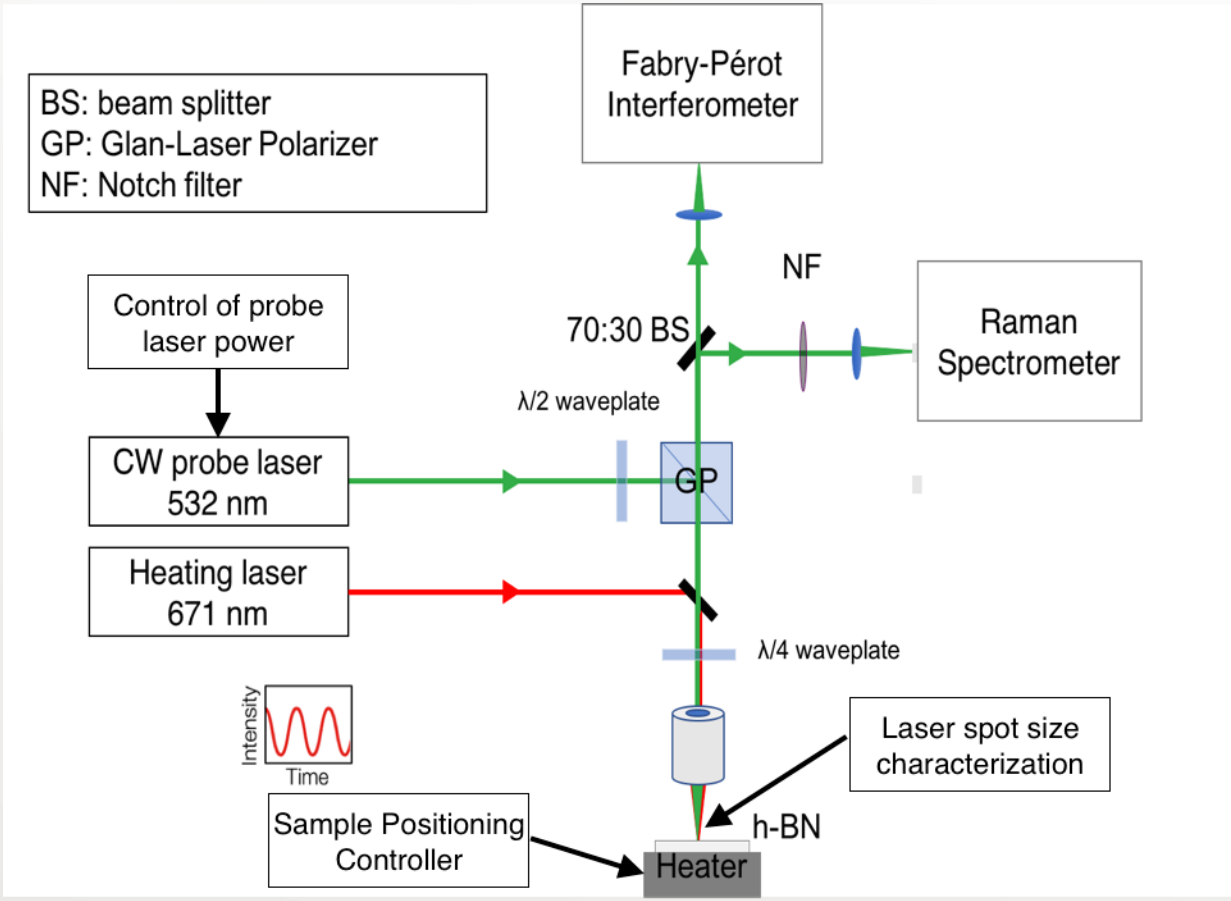
Overview of Characterization System

- Raman and BLS can provide direct measurements of optical and acoustic phonons





Contact vs Non-contact

Contact-Based

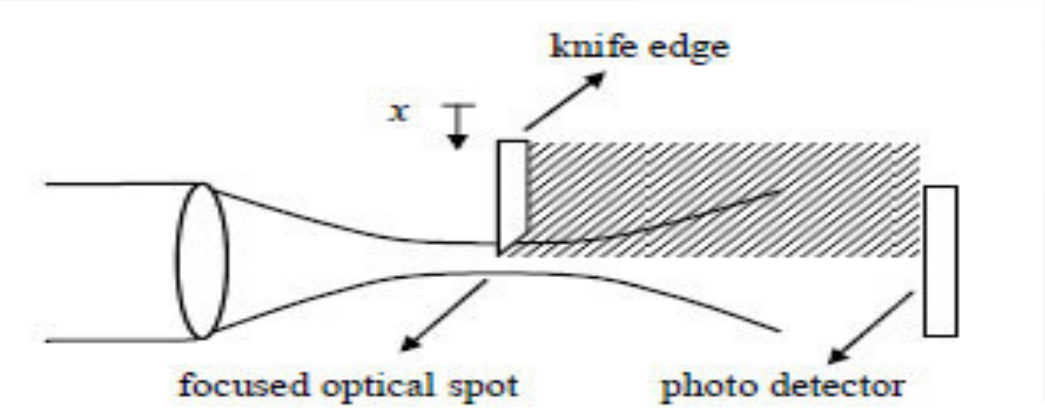
- At the interface between a sample and a contact (e.g. thermocouple), Kapitza resistance causes a temperature drop
- Contact resistance can dominate the low intrinsic resistance of the sample

Non-Contact Based

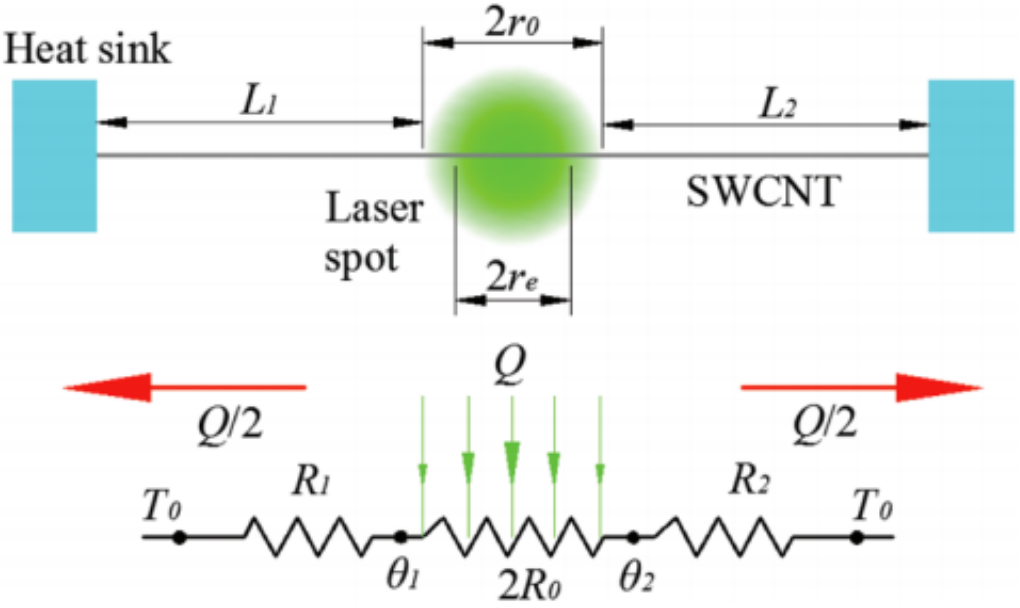
- Optical measurements of temperature often have large uncertainties, poor temperature sensitivity, or complex analysis

Knife-Edge Method

- Measures optical signal as a function of position

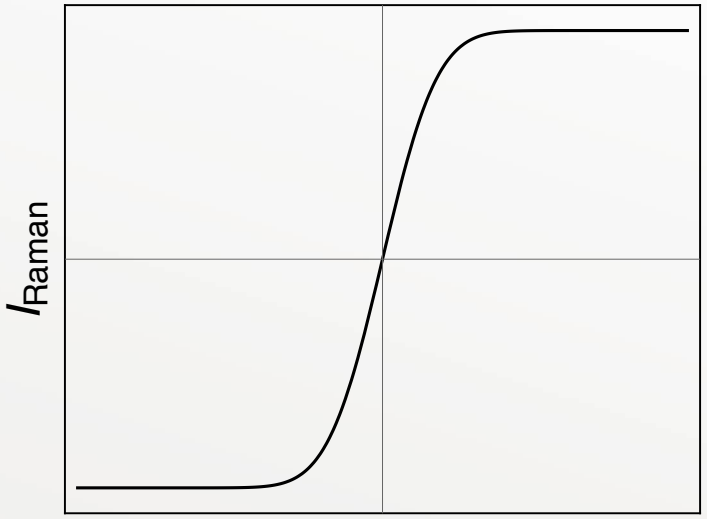


- Allows us to determine laser spot size



Precise Laser Spot Measurement

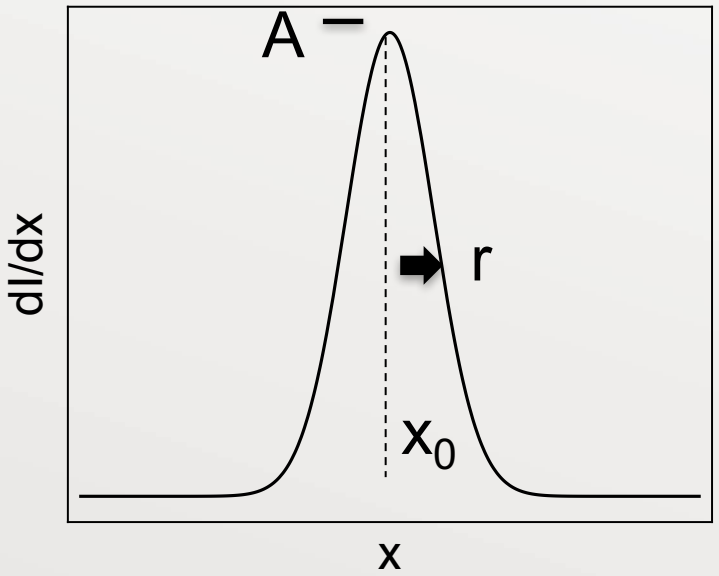
- Measured Raman intensity as a function of position is approximately a Gauss error function



- Its derivative is a Gaussian:

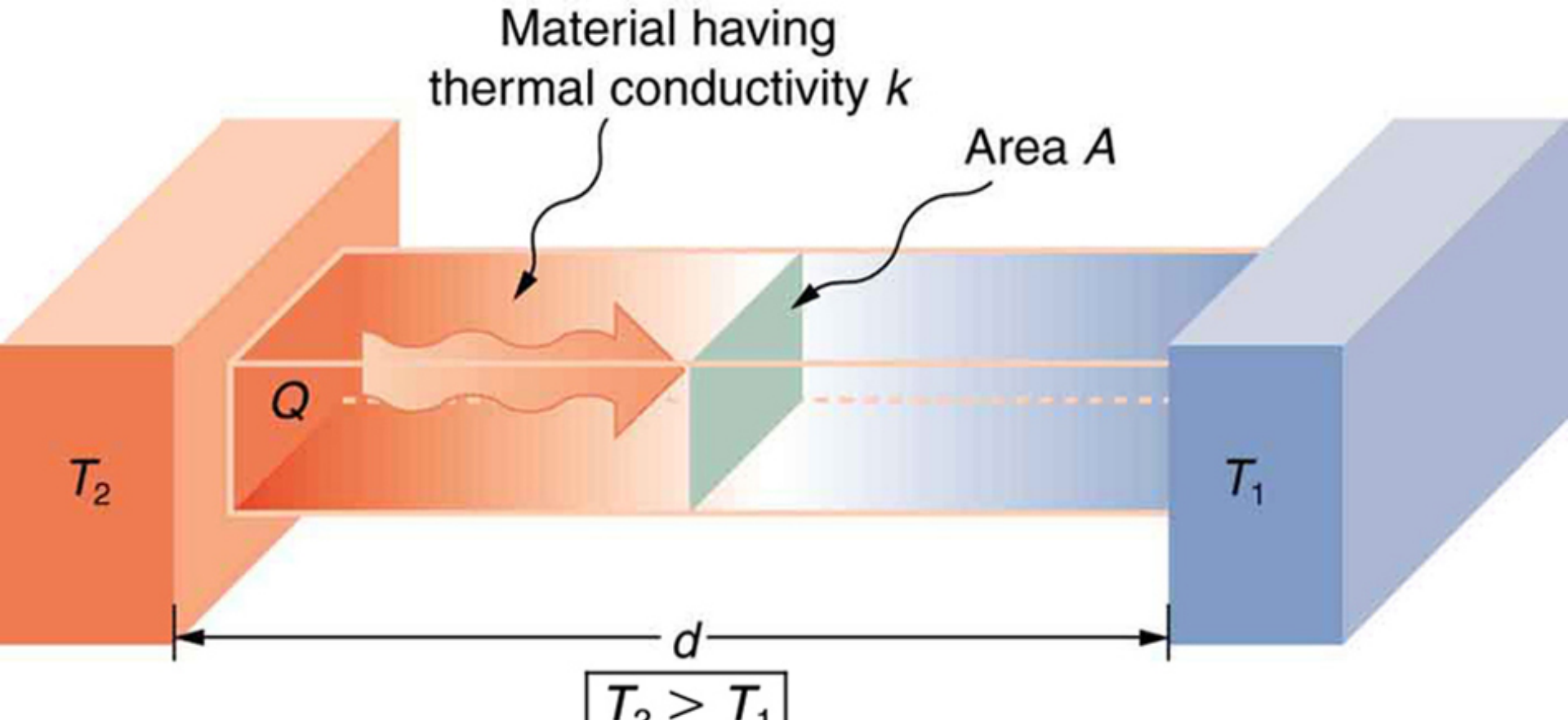
$$\frac{\partial I}{\partial x}(x) = Ae^{-\frac{(x-x_0)^2}{r^2}}$$

Gaussian beam radius

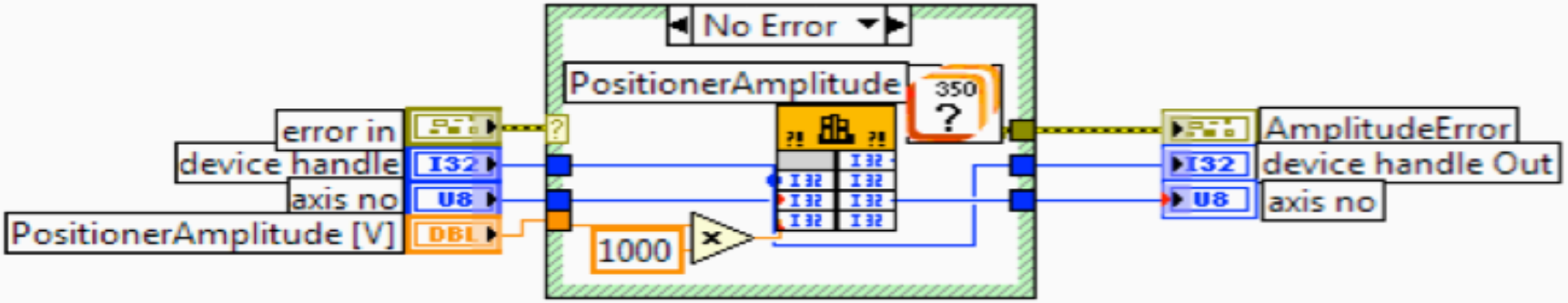


Thermal Conductivity

- Fourier relation: $\dot{Q} = -k\nabla T$

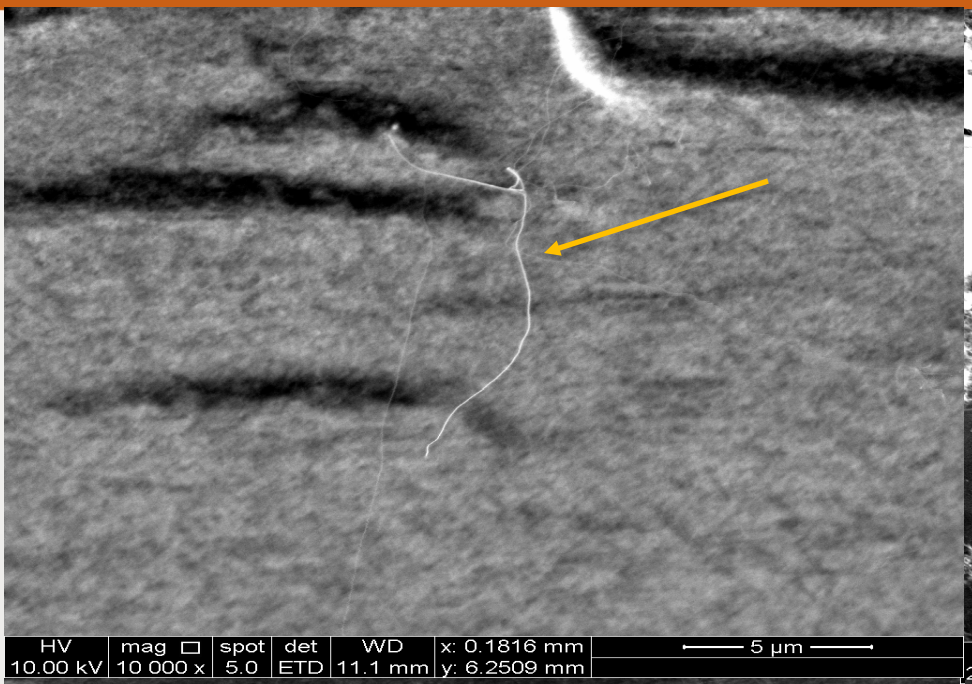


ANC350 Piezo Controller



Carbon Nanotubes

- Aim: 100 μm CNT
- Catalyst: Fe film deposited using e-beam deposition
- Temp: 950º C
- Pretreat: Ar at 200 sccm and H_2 at 60 sccm
- Growth: CH_4 at 150 sccm and H_2 at 75 sccm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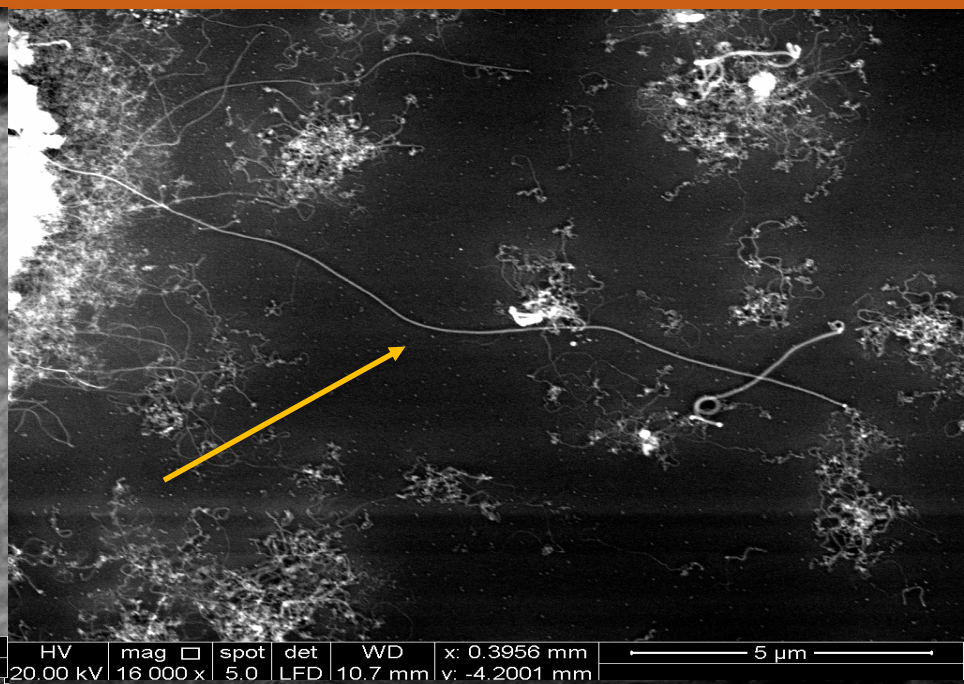
mag 10 000 x
spot 5.0
det ETD
WD 11.1 mm
x: 0.1816 mm
y: 6.2509 mm
5 µm


HV 20.00 kV
mag 16 000 x
spot 5.0
det LFD
WD 10.7 mm
x: 0.3956 mm
y: -4.2001 mm
5 µm


HV 10.00 kV
mag 10 000 x
spot 5.0
det ETD
WD 11.1 mm
x: -0.2301 mm
y: 6.4546 mm
5 µm


HV 10.00 kV
mag 10 000 x
spot 5.0
det ETD
WD 11.1 mm
x: -0.1939 mm
y: 6.4546 mm
5 µm

Next Steps

- Finish growing 100 μm CNTs
- Develop automated piezo controlled stage movements

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