RAMAN IMAGING FOR SPATIALLY RESOLVED THERMAL CHARACTERIZATION OF MATERIALS AND OPERATING DEVICES

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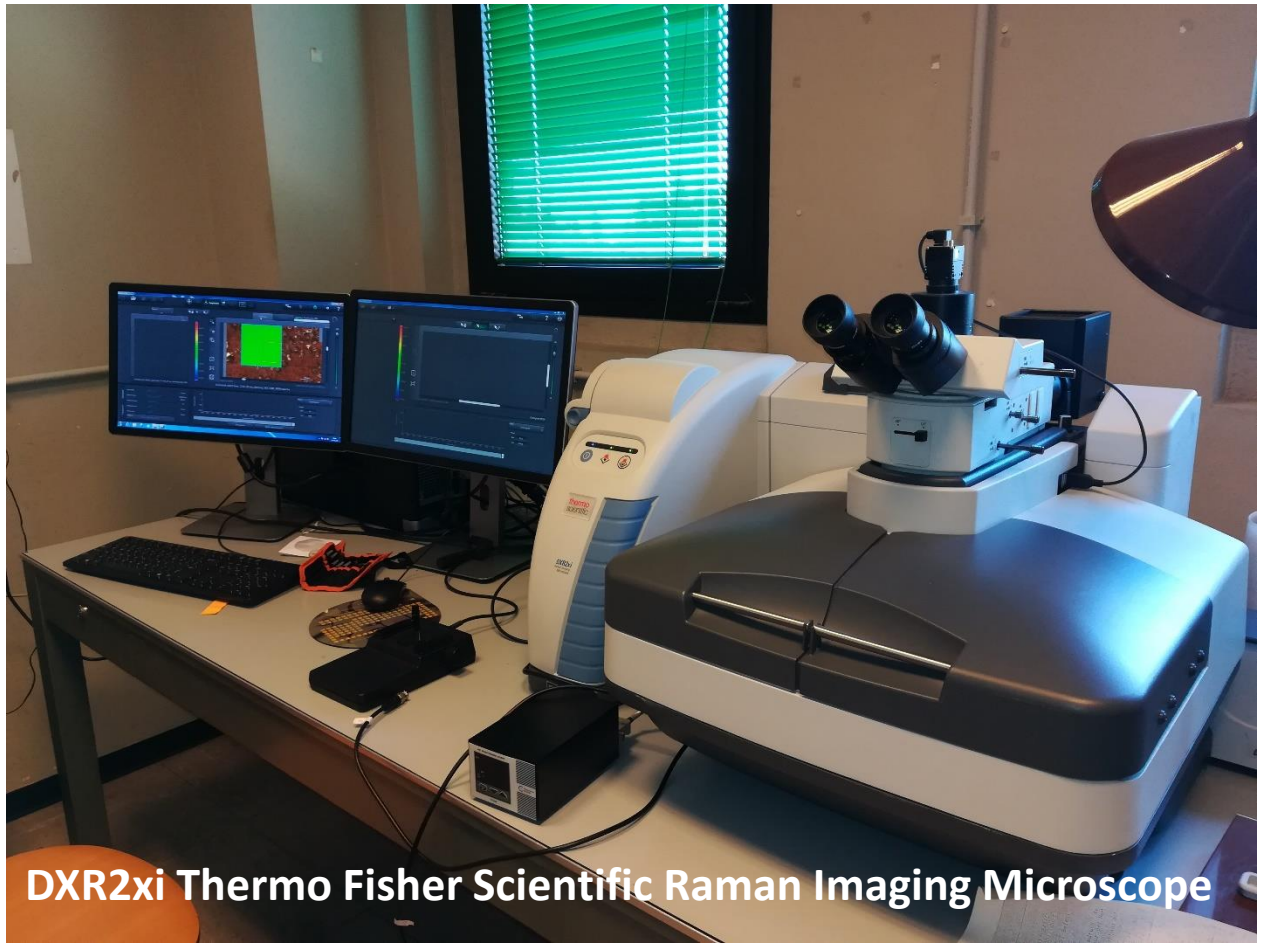
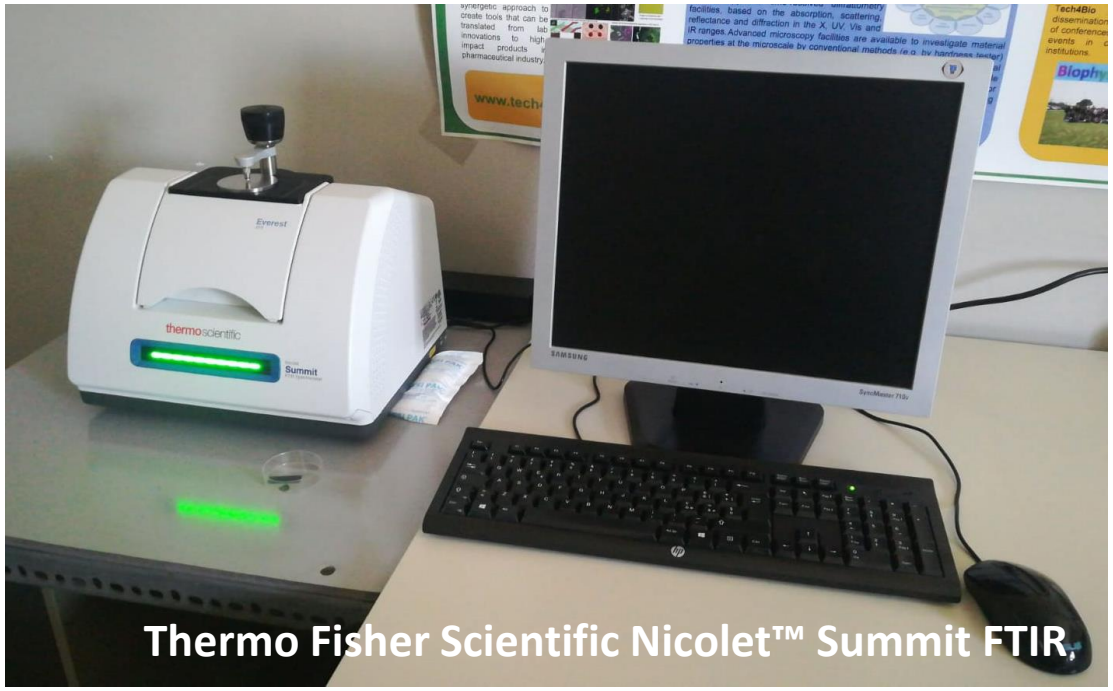
Nano Innovation 2020 Rome, 15-18 September Conference & Exhibition

VisLab RAMAN AND FTIR FACILITIES



DXR2xi Thermo Fisher Scientific Raman Imaging Microscope



Thermo Fisher Scientific Nicolet™ Summit FTIR,

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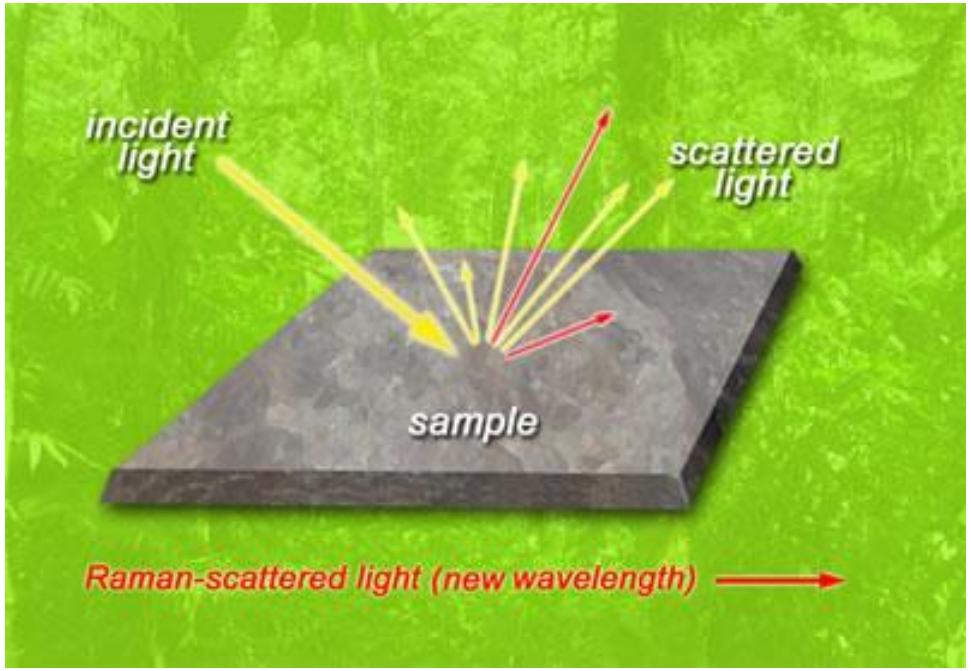
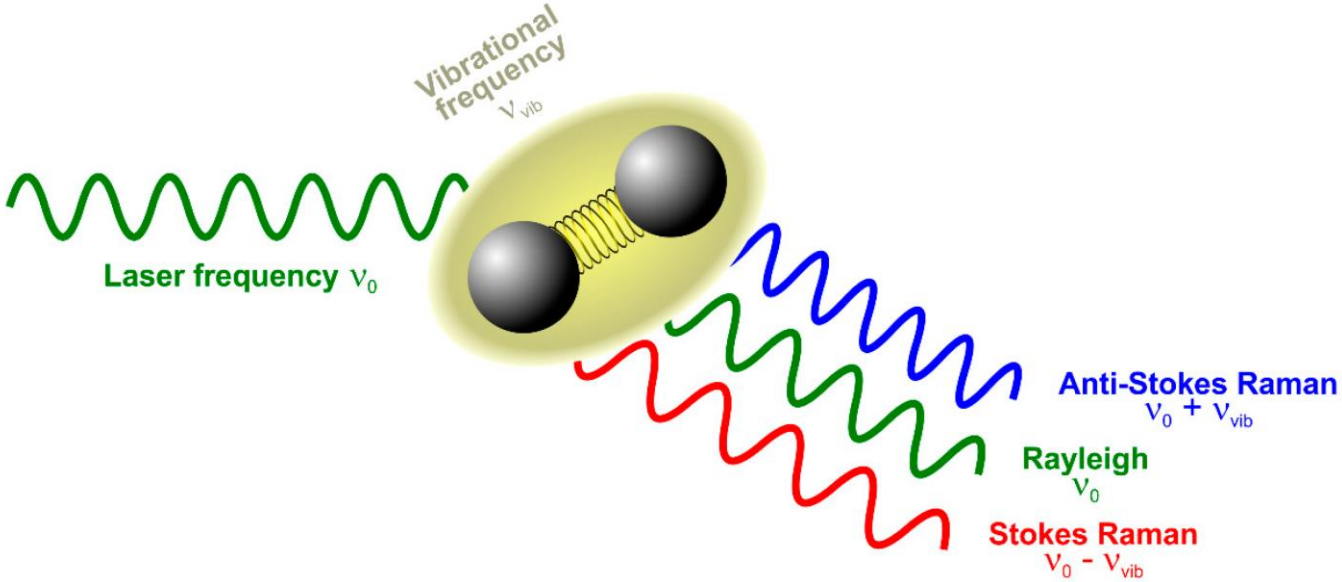
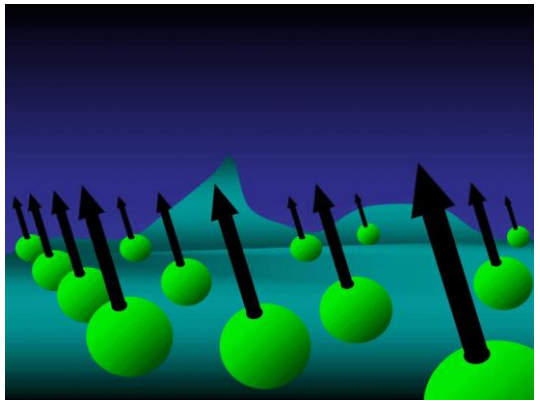
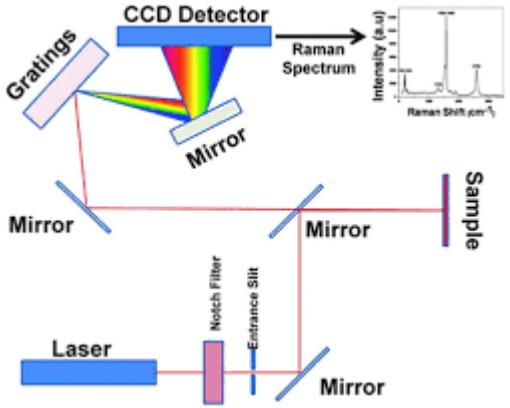
RAMAN (INELASTIC) SCATTERING = PHYSICO-CHEMICAL INFORMATION

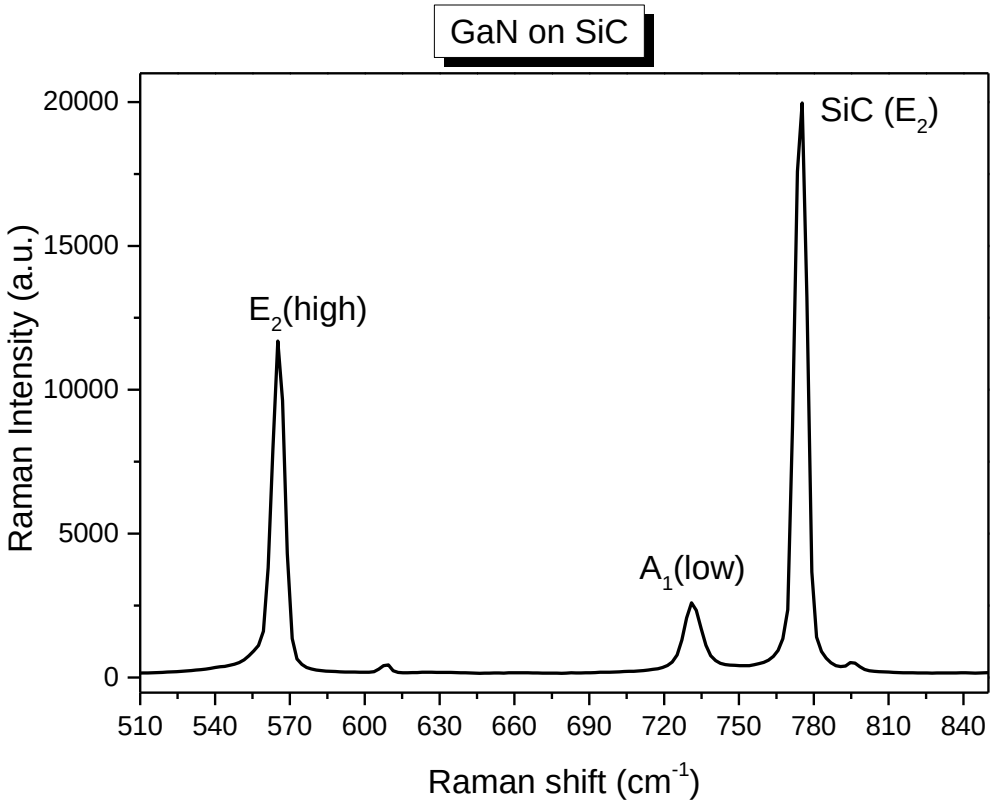




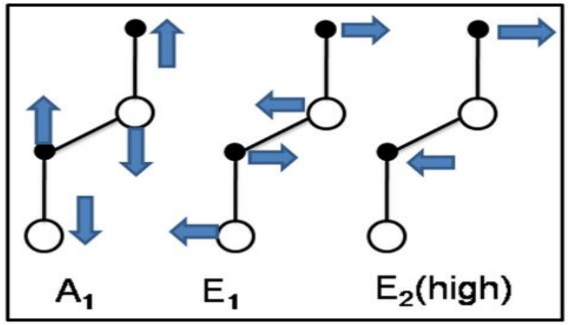
RAMAN "SIGNATURE"

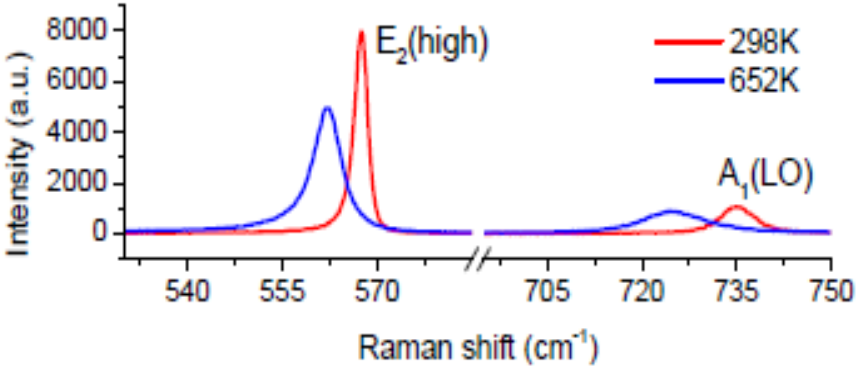


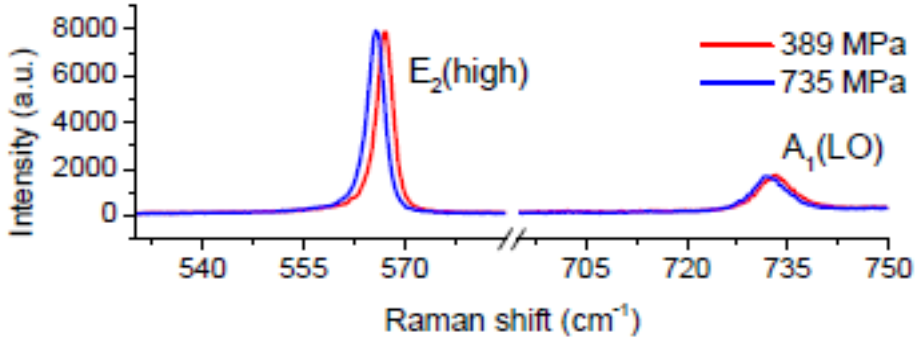




PICCO	SHIFT RAMAN (cm^{-1})
E_2(high)	≈ 565
A_1(low)	≈ 732
E_2(SiC)	≈ 775







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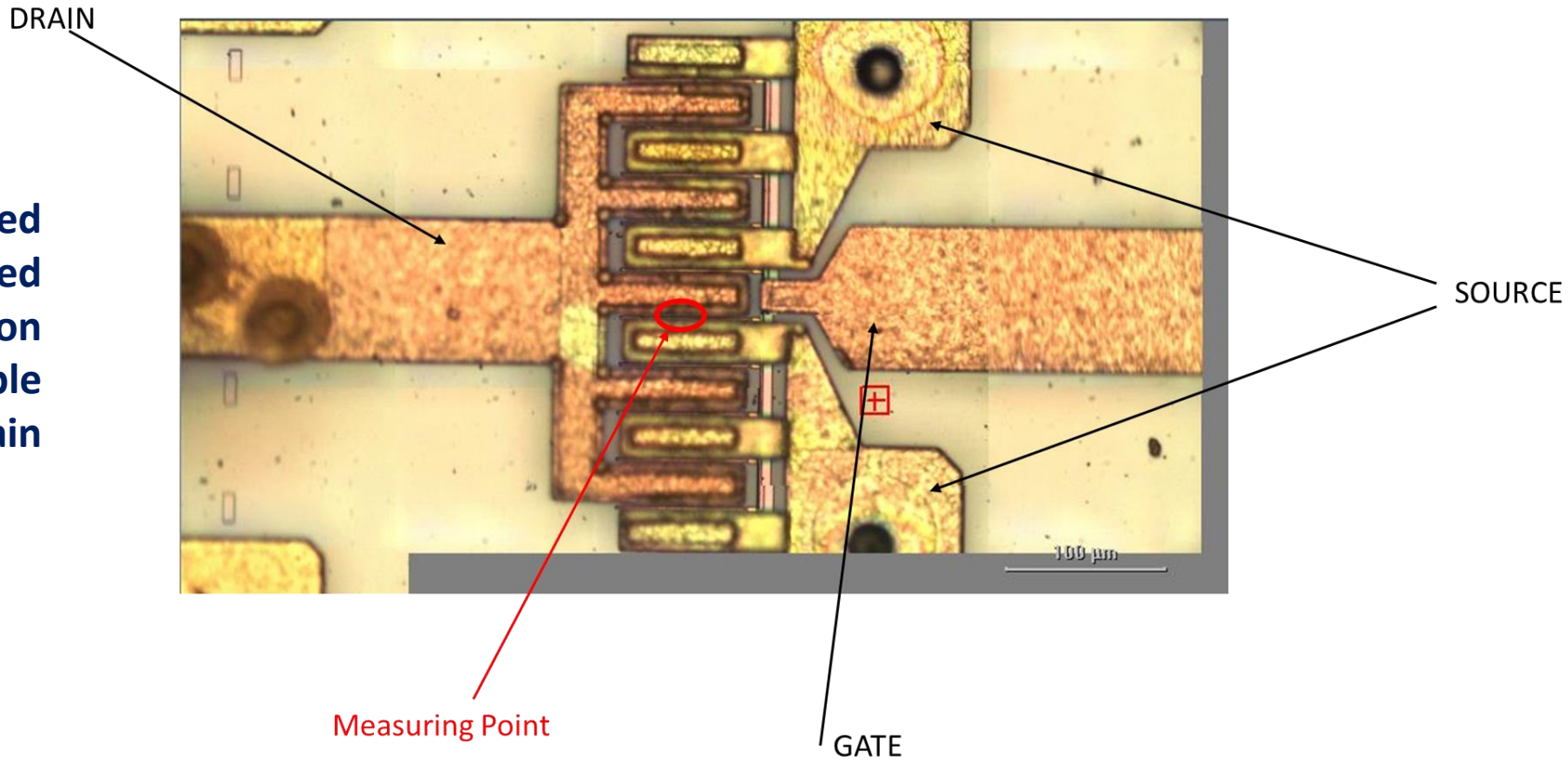
IMAGING CAPABILITIES: HEMT DEVICES

DISSIPO Project (KETs – TECNOLOGIE ABILITANTI Call, Regione Lazio)

Ambiente Di Simulazione In-tegrato Elettromagnetico Termico e FiSico per l'ottimizzazione delle preStazioni in dIspositivi di POtenza a Semiconduttori

Comparison of calculated and Raman measured temperatute distribution in the optically accessible region between drain and gate



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LEONARDO

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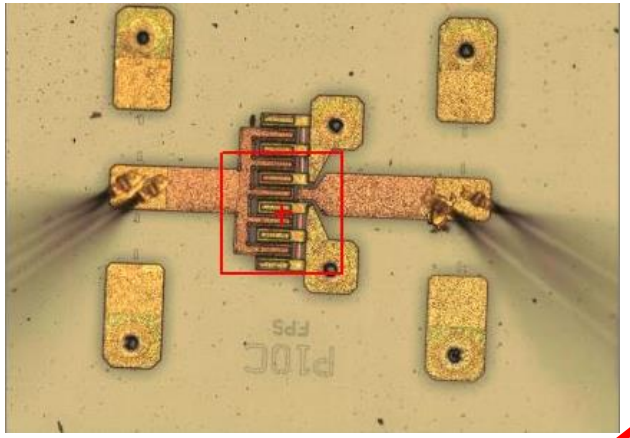
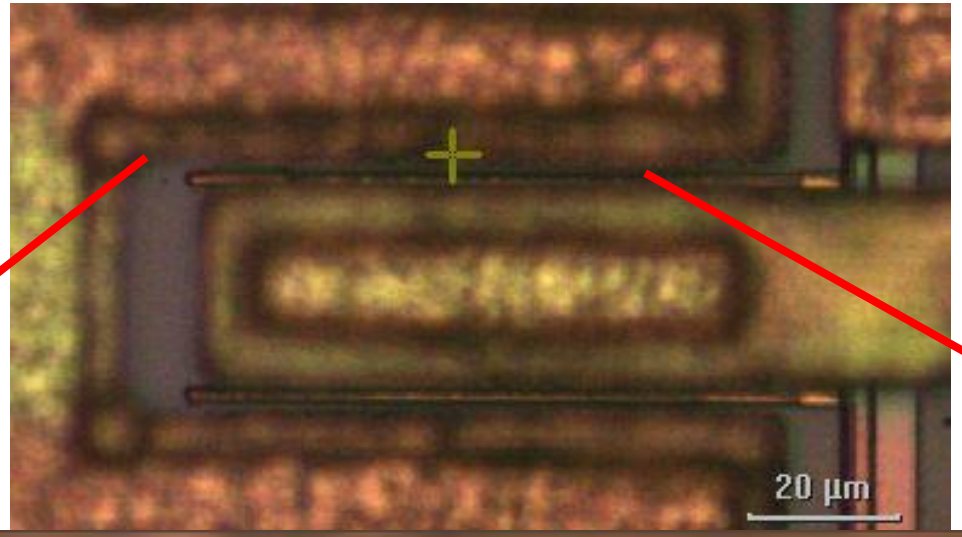
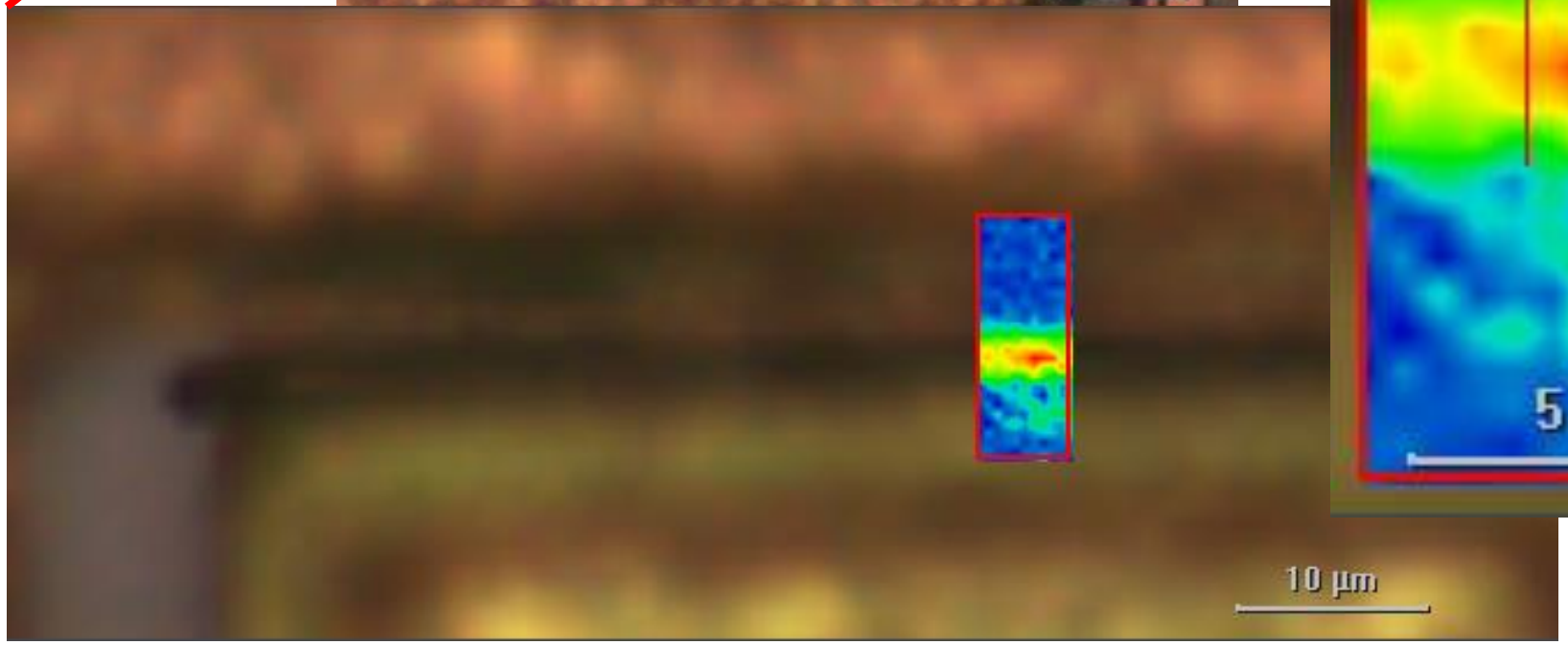
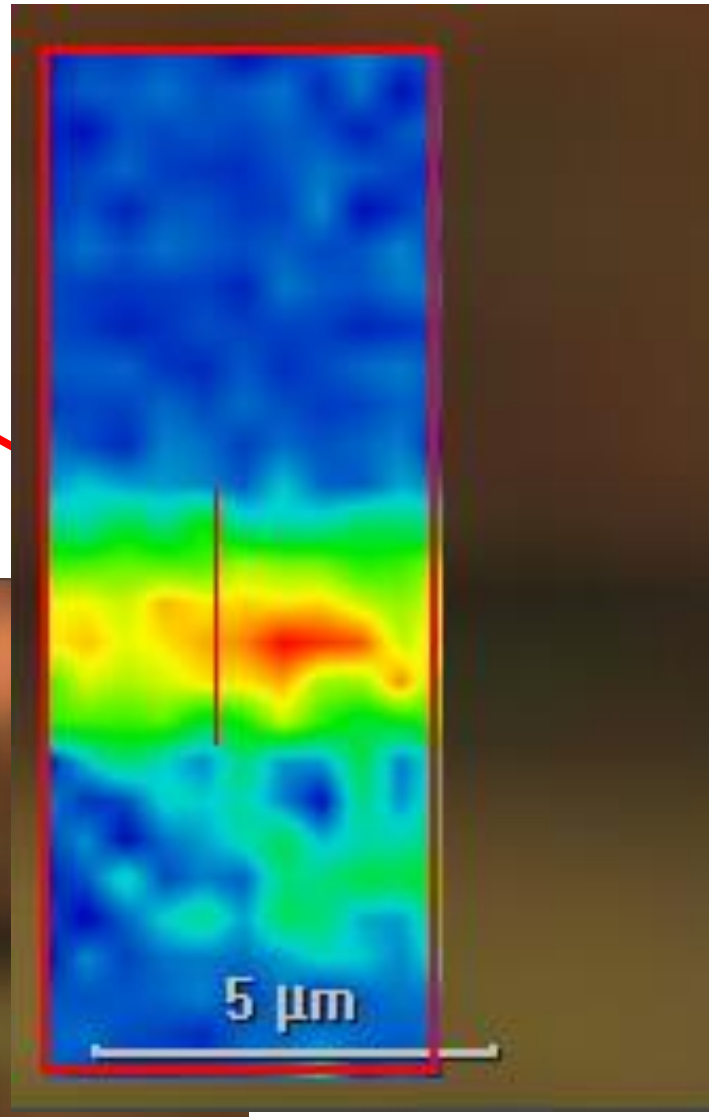
IMAGING CAPABILITIES









P ≈ 1mW
Spot size = 0.8 µm
λ_{exc} = 532 nm
LFD_OBJ 50X

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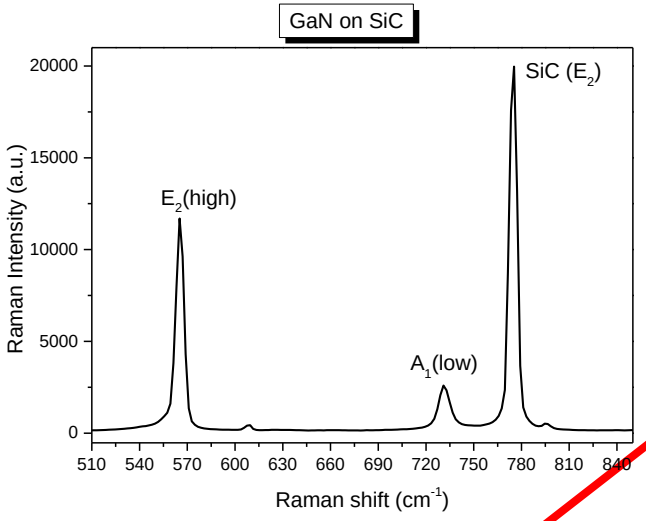
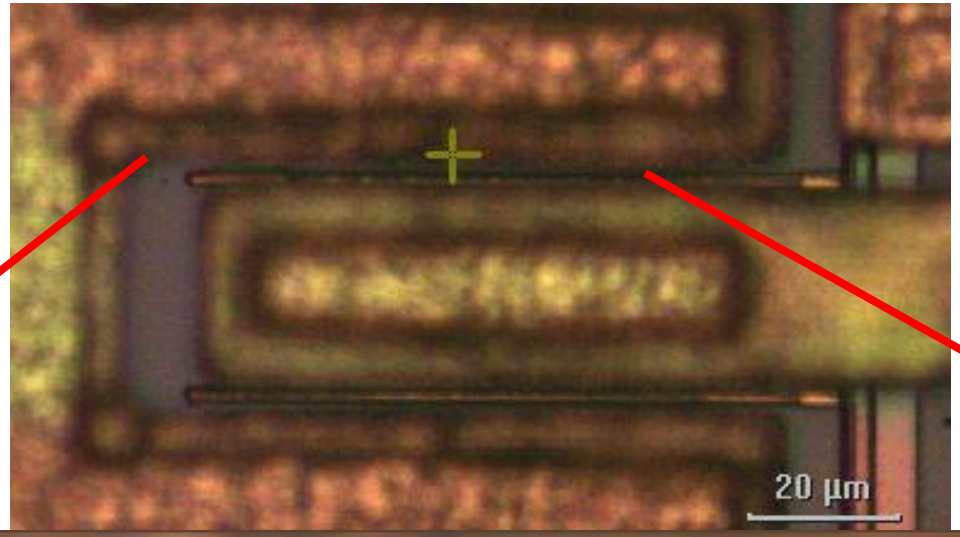
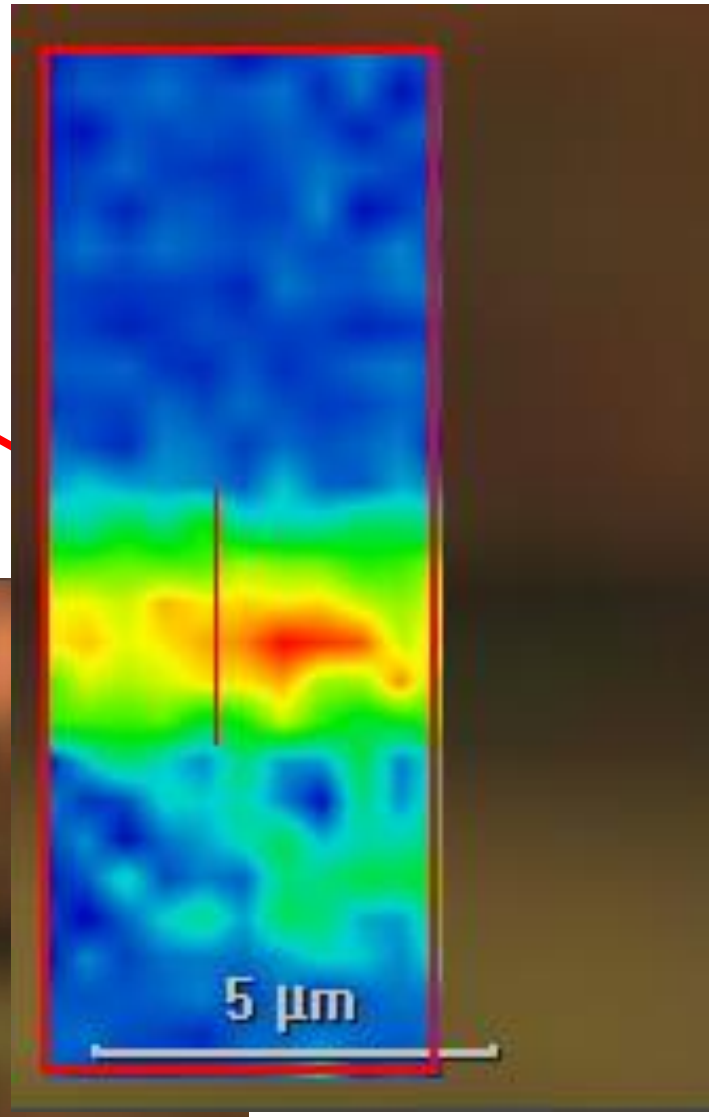
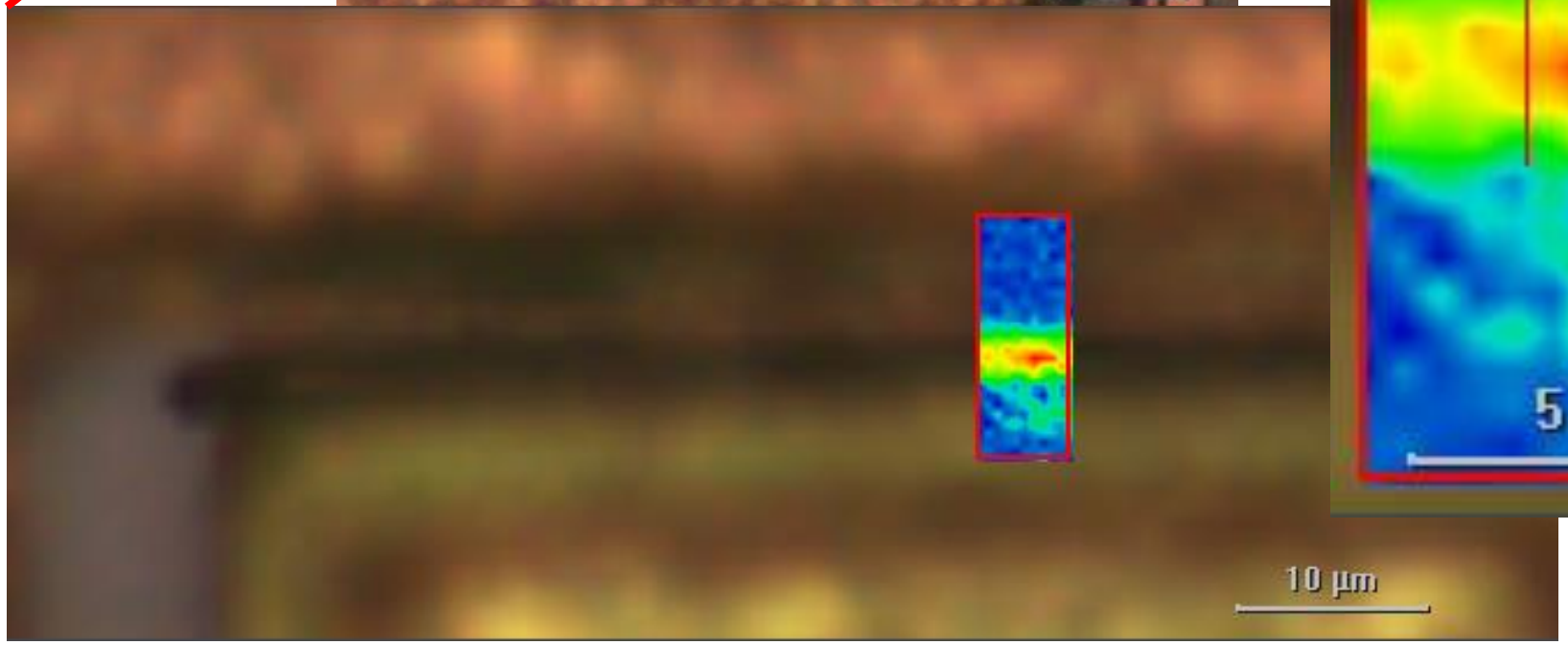
IMAGING CAPABILITIES









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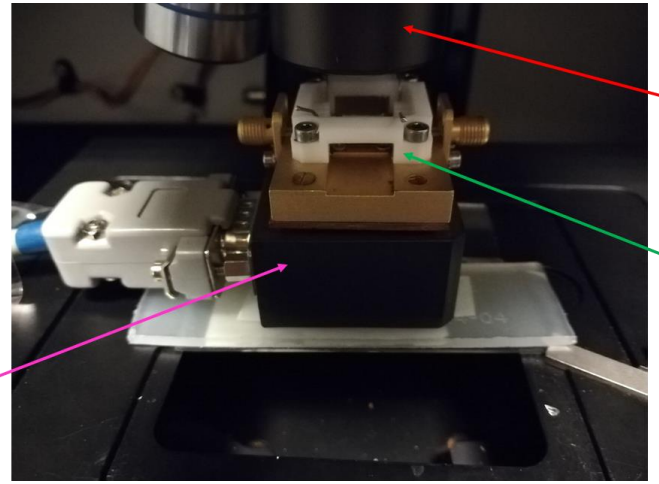
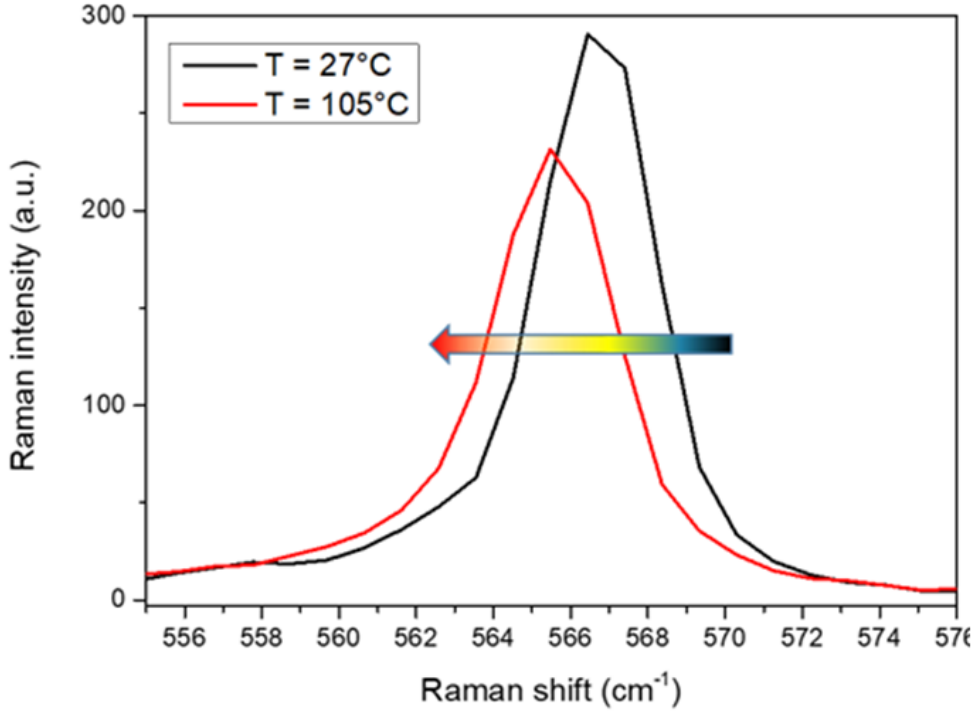
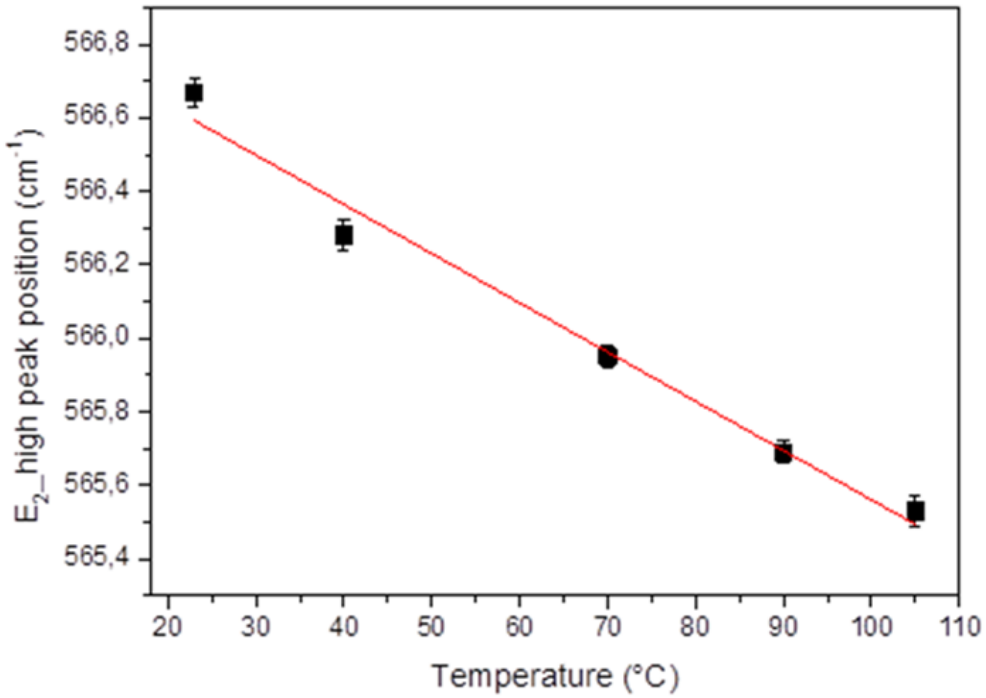
CALIBRATION



$$\Delta\omega = \omega_0 - \frac{A}{e^{\left[\frac{B\hbar\omega_0}{K_B T}\right]} - 1}$$

P ≈ 1mW
Spot size = 0.8 μm
λ_{exc} = 532 nm
LFD_OBJ 50X





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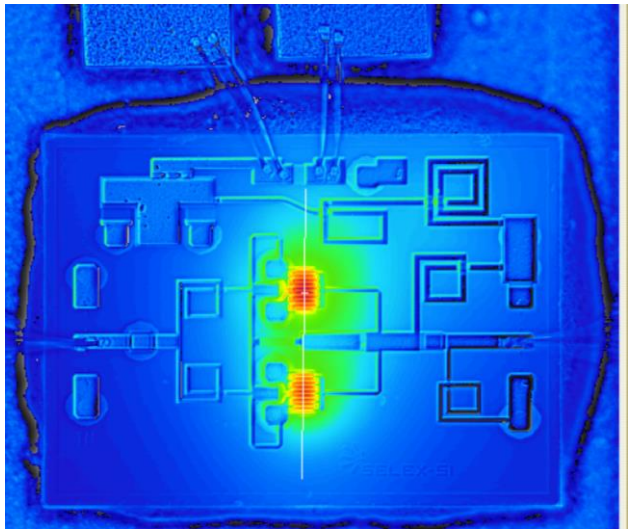
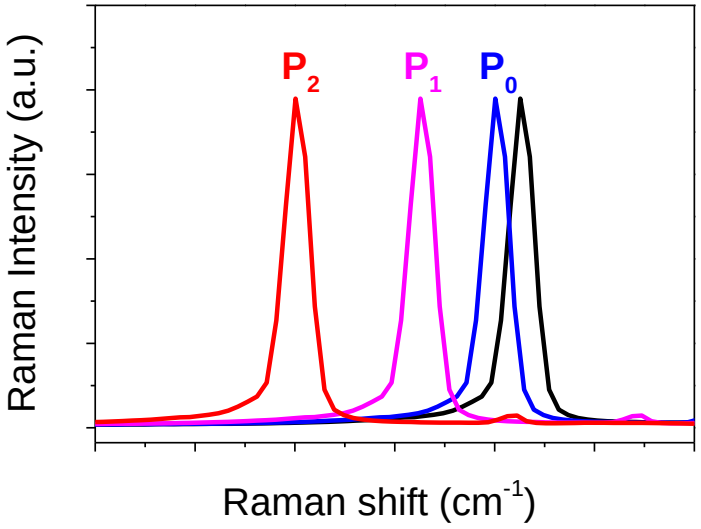
RAMAN THERMOGRAPHY DURING DEVICE OPERATION



$$T = \frac{B\hbar\omega_0}{K_B Ln[1 + \frac{A}{\omega_0 - \omega}]}$$



P ≈ 1mW
Spot size = 0.8 μm
λ_{exc} = 532 nm
LFD_OBJ 50X

	V_{ds} *V*	V_{gs} *V*	I_{ds} *mA*	P diss *W/mm*	Δw (E_2_high) *cm^{-1}*	Δw (A1_low) *cm^{-1}*	T_{ch} *°C*	R_{th} *°Cmm/W*
P0	30	-7	1.5	-				
P1	30	-3.2	76	**3**	(0,49 ±0,04)	(1,7 ± 0,1)	**(87 ± 4)**	(20 ± 1)
P2	30	-3.03	98.5	**3,94**	(0,81 ± 0,04)	(2,4 ± 0,1)	**(111 ± 4)**	(21 ± 1)

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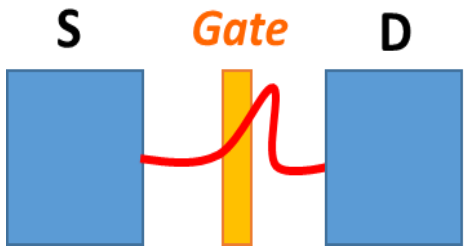
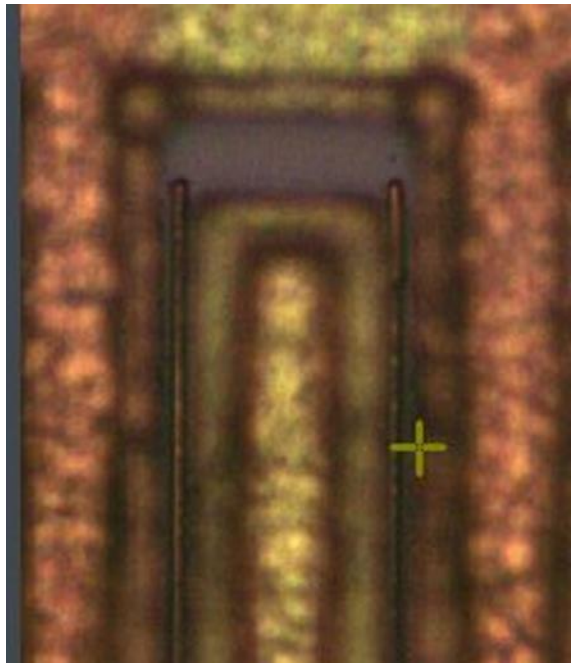
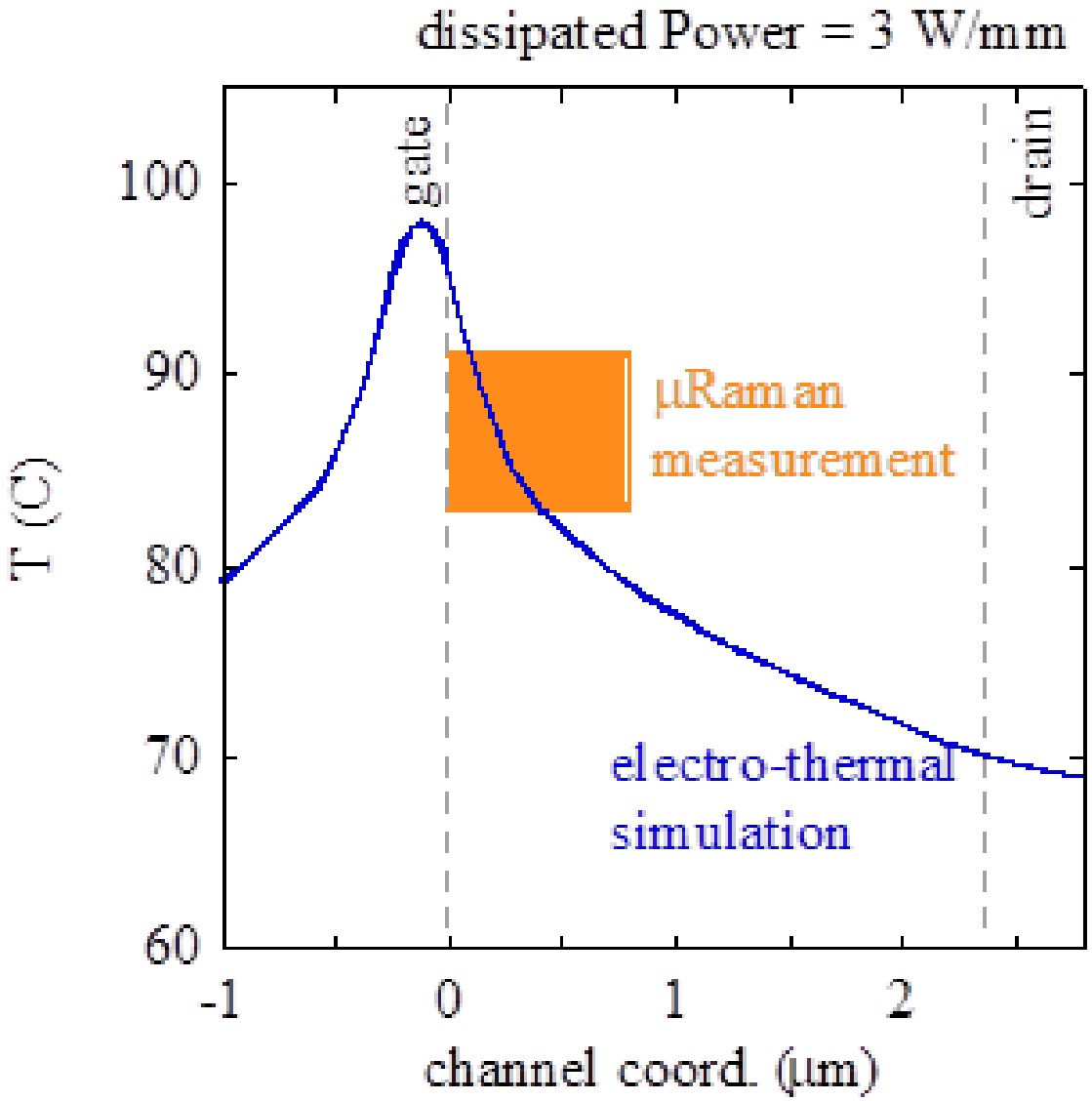
COMPARISON WITH SIMULATIONS







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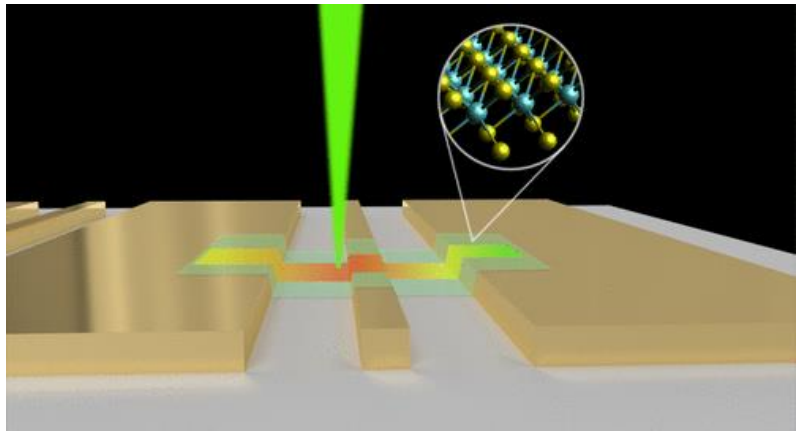
RAMAN THERMOGRAPHY@NANOMICROFAB:

- High spatial resolution characterization (≈ 1 μm):
- Spatial Mapping/Imaging;
- Non-contact, Non-invasive (analysis during device operation);
- Vertical information on different layers and substrate thicknesses;
- No dependance on specific emissivity of different elements/materials (IR);
- Physico-Chemical, Thermal, Strain information;



THANK YOU FOR YOUR ATTENTION

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