Annual Report 2018/2019

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National Enterprise for nanoScience and nanoTechnology

NEST

Annual report

CORSI FREQUENTATI CON SOSTENIMENTO DI ESAME FINALE ATTENDED COURSES (WITH FINAL EXAM)	VOTAZIONE RIPORTATA MARK	NUMERO DI ORE HOURS
Nanostructured materials	27	40
Physics of nanostructures	24	44
Theory of Many-Body Systems		40

CORSI FREQUENTATI SENZA SOSTENIMENTO DI ESAME FINALE ATTENDED COURSES (ATTENDANCE ONLY)	NUMERO DI ORE HOURS
Italian language Course A1.2	40

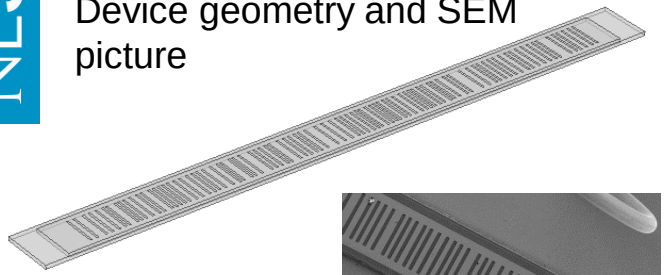
ALTRE ATTIVITÀ FORMATIVE (SEMINARI, WORKSHOP, SCUOLE ESTIVE, ECC.) – DESCRIZIONE OTHER PHD ORIENTED ACTIVITIES (SEMINARS, WORKSHOPS, SUMMER SCHOOLS, ETC) – DESCRIPTION	NUMERO DI ORE HOURS
Horizon 2020 and Building of the European Research Area	20
Graphene Study 2019	30

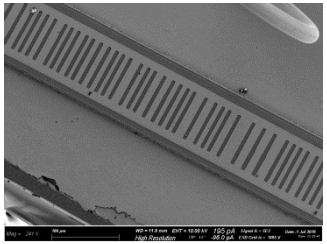
EVENTUALI PUBBLICAZIONI
PUBLICATIONS (IF AVAILABLE)

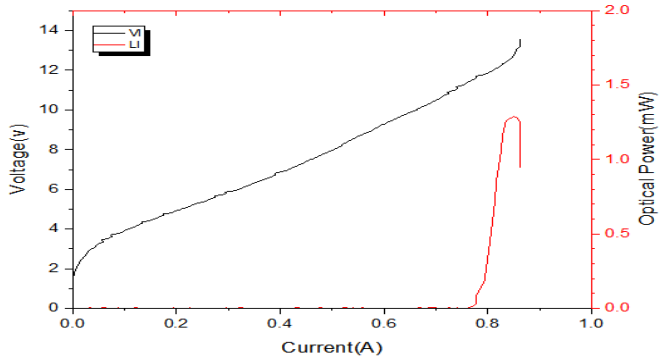
Il'ichev, E., Khaustov, V., Kuleshov, A., Migunov, D., Minakov, P., Nabiev, R., Petrukhin, G., Teverovskaya, E. & Rychkov, G. (2019). Analysis and experimental research on graphene's electron transparency and its application for the development of micro-and nanoelectronic devices. Diamond and Related Materials, 94, 209-217.

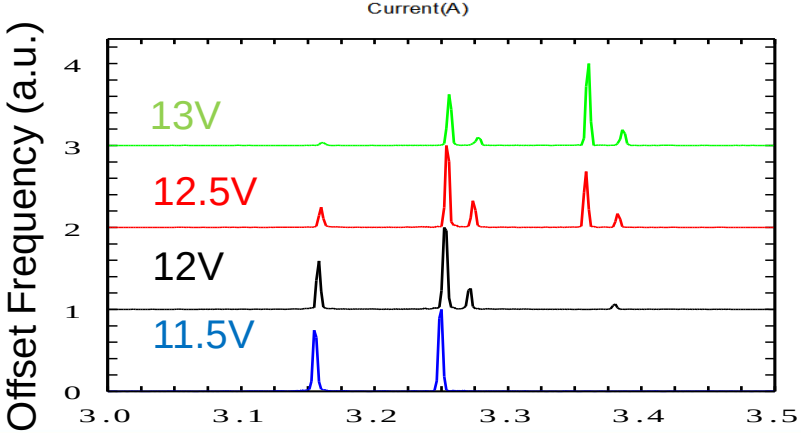
1D-Random THz QCL (Miriam Vitiello group)

Device geometry and SEM picture



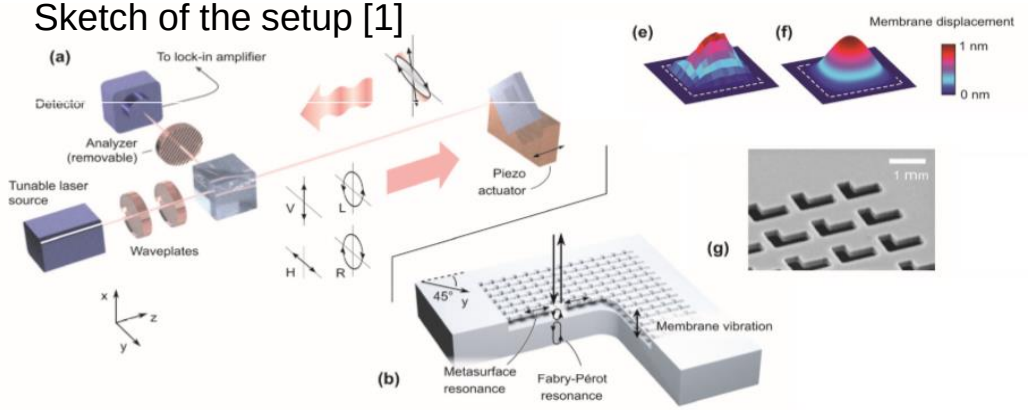


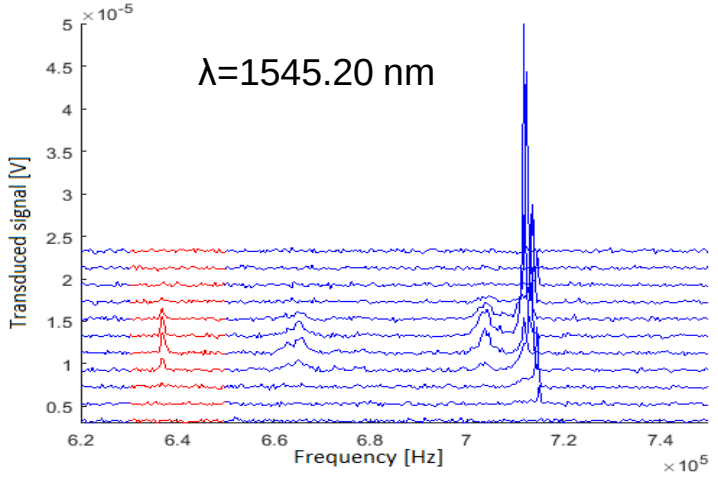


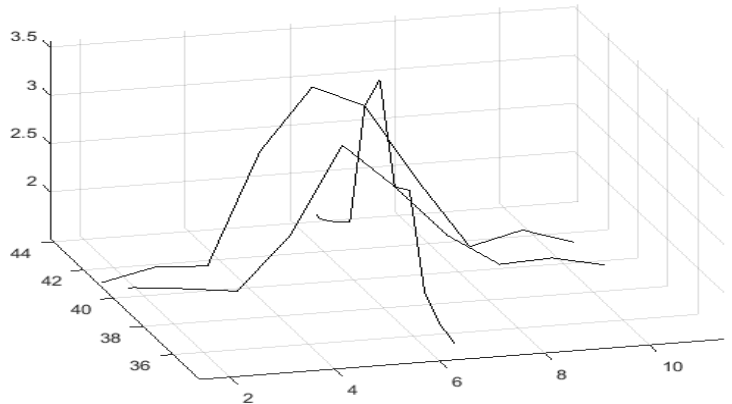


Optical characterization of metasurfaces (Alessandro Pitanti group)

Sketch of the setup [1]

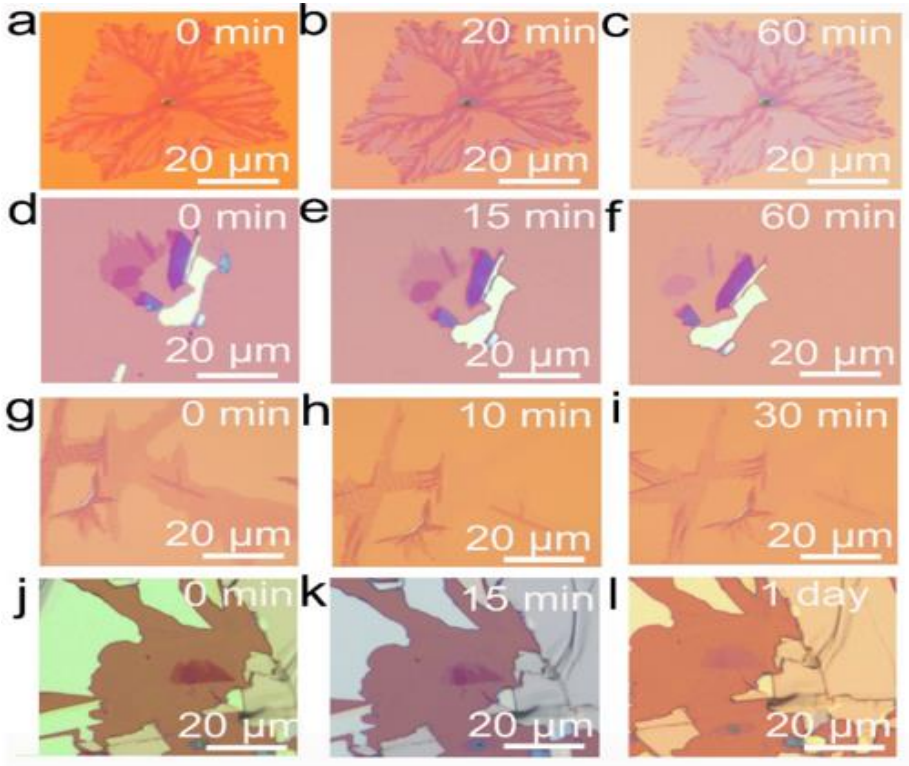


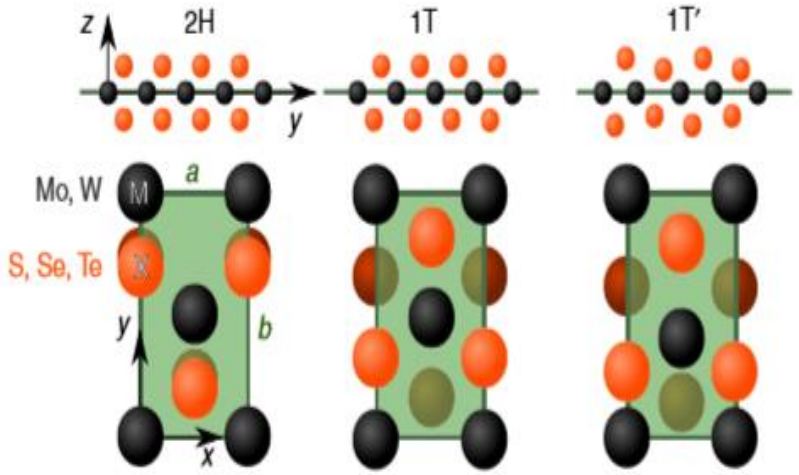




Structural phase transition in Transition Metal Dichalcogenides

W/$MoTe_2$ air instability [2]

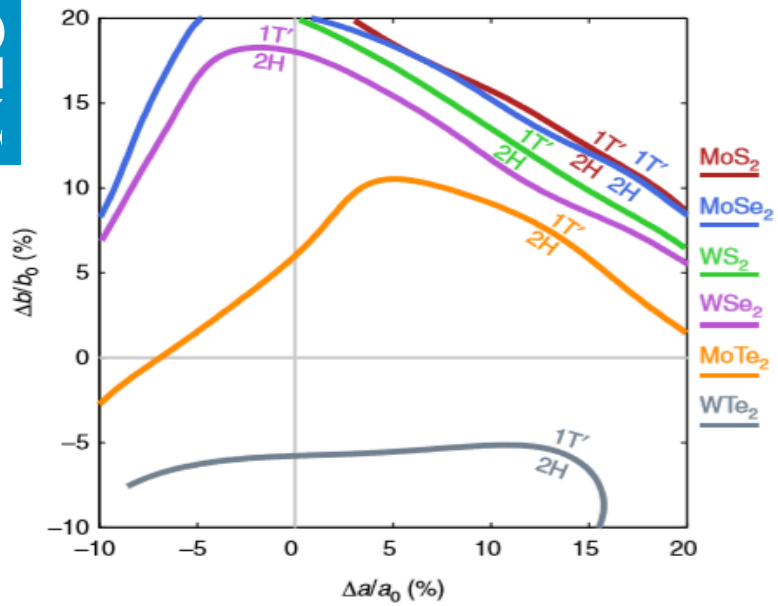




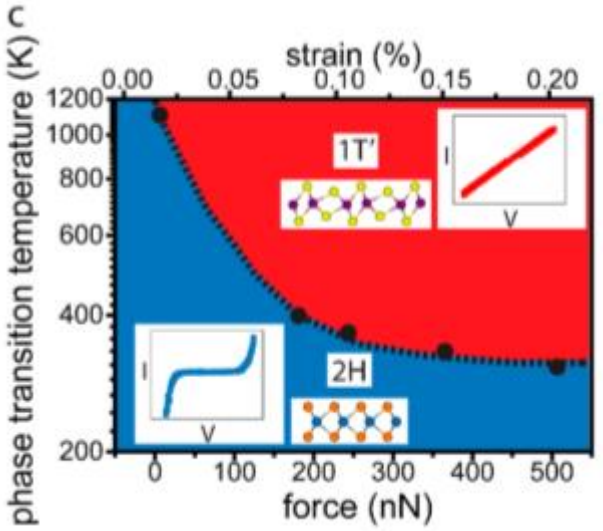
The three crystalline phases of 2D group VI TMDs [3].

a-c) monolayer CVD WTe_2
d-f) exfoliated few-layer WTe_2
g-i) monolayer CVD $MoTe_2$
j-l) exfoliated few-layer $MoTe_2$

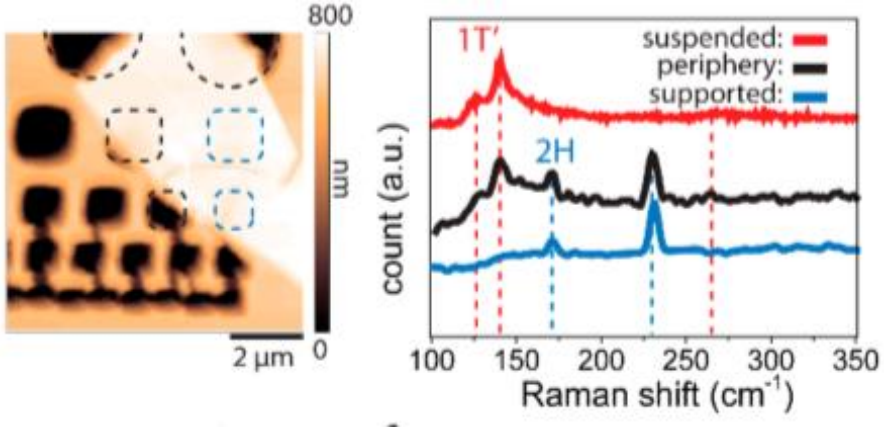
Strain and temperature induced SPT



Intersection contours of the 2H and 1T' energy surfaces when varying the rectangular lattice constants a and b [3].



Modulating the phase transition temperature of $MoTe_2$ by strain [4].



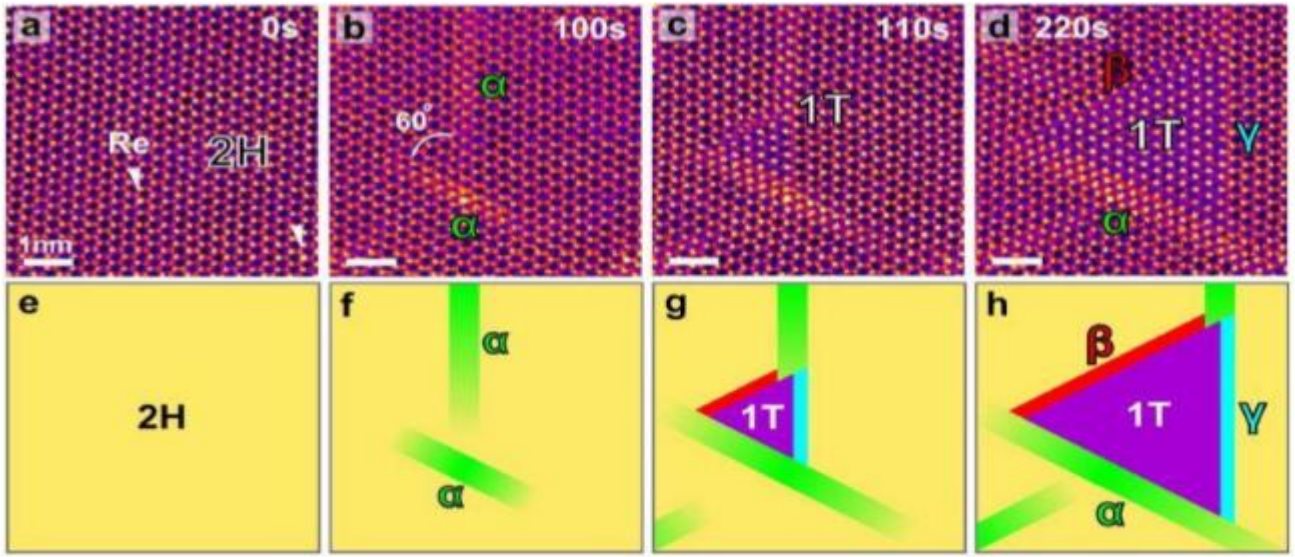
AFM image and Raman spectra taken at the outside (supported), periphery, and the center (suspended) of the cavities showing different Raman signatures of 2H and 1T′ under **0.2%** strain and **room temperature** [4].

Unexplored SPT

- Chemical doping
- Electric field
- Piezoelectric effect

Tasks

1) Exploring air stability in W/$MoTe_2$
2) Exploring structural phase transitions in W/$MoTe_2$



An alternative approach to induce a SPT by Rhenium (Re) intercalation and thermal annealing in MoS_2[5].

References

1) Zanotto, Simone, et al. "Optomechanics of chiral dielectric metasurfaces." *arXiv preprint arXiv:1810.01773* (2018).

2) Zhou, Jiadong, et al. "Large-area and high-quality 2D transition metal telluride." *Advanced Materials* 29.3 (2017): 1603471.

3) Duerloo, Karel-Alexander N., Yao Li, and Evan J. Reed. "Structural phase transitions in two-dimensional Mo-and W-dichalcogenide monolayers." *Nature communications* 5 (2014): 4214.

4)Song, Seunghyun, et al. "Room temperature semiconductor–metal transition of MoTe2 thin films engineered by strain." *Nano letters* 16.1 (2015): 188-193.

5) Lin, Y. et al. Atomic mechanism of the semiconducting-to-metallic phase transition in singlelayered MoS2. Nat. Nanotech. 9, 391–396 (2014).