SCUOLA
NORMALE
SUPERIORE

RELAZIONE ATTIVITA' ANNUALE DEI PERFEZIONANDI/DOTTORANDI – TERZO/QUARTO ANNO
REPORT ON THE PHD ACTIVITY – THIRD/FORTH YEAR

NOME E COGNOME **NAME AND SURNAME**	Isha Verma
DISCIPLINA **PHD COURSE**	Nanoscience

CORSI FREQUENTATI CON SOSTENIMENTO DI ESAME FINALE ATTENDED COURSES (WITH FINAL EXAM)	VOTAZIONE RIPORTATA MARK	NUMERO DI ORE HOURS

CORSI FREQUENTATI SENZA SOSTENIMENTO DI ESAME FINALE ATTENDED COURSES (ATTENDANCE ONLY)	NUMERO DI ORE HOURS
Corso COVID	2 hour

ALTRE ATTIVITÀ FORMATIVE (SEMINARI, WORKSHOP, SCUOLE ESTIVE, ECC.) – DESCRIZIONE OTHER PHD ORIENTED ACTIVITIES (SEMINARS, WORKSHOPS, SUMMER SCHOOLS, ETC) – DESCRIPTION	NUMERO DI ORE HOURS
Synthetic Design of Chromophore/Metal Oxide Semiconductor Interfaces for Solar Energy Applications by Elena Galoppini.	1 hour
High-Quality InP based Etching- achieving smooth surface using controlled processing by Dr. Katie Hore (Webinar organized by Oxford instruments).	1 hour
Quantum transport in dual-channel InAs/InP/GaAsSb core-shell nanoscale devices and Graphene/ultrathin-Si_3N_4 heterostructure device by Dr. Sedighe Salimian.	1 hour
Making and Analyzing Semiconductor Devices – A Group of Solutions from Oxford Instruments.	1 hour
Relevant Performance Parameters for professional EBL: About Truth and Myth.	1 hour
ZEISS Autumn School of Semiconductor Optics.	5 hour
Project- SuperTOP QuantERA, second year meeting.	6 hour

ATTIVITÀ DI RICERCA SVOLTA (MAX. 8.000 CARATTERI)*
RESEARCH ACTIVITY (MAX. 8000 CHARACTERS)

Growth of InSb nanostructures via Chemical beam epitaxy and their transport properties

Research interest in indium antimonide (InSb) has increased significantly in recent years owing to its intrinsic properties and the consequent opportunities to implement next-generation quantum devices. Hence, the precise, reproducible control over morphology and crystalline quality becomes of paramount importance for a practical quantum-device technology. The goal of my thesis is to investigate the growth dynamics and characterization of InSb nanostructures with different morphologies.

Project 1: Morphology control of single-crystal InSb nanostructures by tuning growth parameters

InAs/InSb hetero-nanostructures such as nanowires (1D), nanoflags (2D) and nanocubes (3D) were grown by means of Au-assisted chemical beam epitaxy by tailoring the growth parameters like growth temperature, precursor fluxes, sample rotation and substrate orientation. In particular, all the as-grown InSb 2D nanoflags (NFs) are found to be single-crystalline with zinc blende structure, free from any defects such as stacking faults and twin planes. The existence of two families of 2D nanostructures, characterised by an aperture angle at the base of 145° and 160°, is observed and modelled. This study provides useful guidelines for the controlled growth of high-quality InSb nanostructures with different shape. [1]

Project 2: Growth of InP/InSb heterostructure nanoflags via Au-assisted CBE and their transport properties

Since 2D InSb NFs provides more freedom to fabricate devices with respect to NWs while still having the pristine nanoscale surface, it becomes viable system for quantum devices. The aim of the project was to increase the dimension of InSb NFs to be employed for device fabrication. By substituting InAs stem with a more robust InP stem following the same growth protocol for InSb NFs [1], there was 3-fold increment in length, 2-fold increment in width while keeping the thickness constant. The magneto-transport properties of InSb nanoflags have been investigated and low temperature Hall mobilities up to ≈25000 $cm^2V^{-1}s^{-1}$ which is the highest reported mobility value [2, 3, and 4] were measured.

Project 3: Growth InP/InSb heterostructure nanoflags via selective area growth (SAG) mechanism

Currently, I am working on an alternative approach for the growth of InSb flags i.e. via selective area growth mechanism. This will allow us to have even larger width flags by merging the InSb segments. Further, the morphology, structure and transport properties of InSb NFs will be investigated.

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References

[1] I Verma, V Zannier, F Rossi, D Ercolani, F Beltram and L Sorba, Morphology control of single-crystal InSb nanostructures by tuning the growth parameters. *Nanotechnology* **31** 384002 (2020)

[2] Mata M D L, Leturcq R, Plissard S R, Rolland C, Magén C, Arbiol J and Caroff P, Twin-Induced InSb Nanosails: A Convenient High Mobility Quantum System. *Nano Lett.* **16** 825 (2016)

[3] Gazibegovic S, Badawy G, Buckers T L J, Shen P L J, Vries F K D, Koelling S, Kouwenhoven L P, Verheijen M A and Bakkers E P A M, Bottom-Up Grown 2D InSb Nanostructures. *Adv. Mater.* **31** 1808181 (2019)

[4] Pan D, Fan D X, Kang N, Zhi J H, Yu X Z, Xu H Q and Zhao J H, Free-Standing Two-Dimensional Single crystalline InSb Nanosheets. *Nano Lett.* **16** 834 (2016)

*se si intende sottoporre una relazione di ricerca più estesa, utilizzare il campo per una descrizione sintetica e allegare il documento in formato .pdf
If you are going to submit a longer report, please fill the box with a synthetic abstract and attach a document in pdf format

EVENTUALI PUBBLICAZIONI **PUBLICATIONS (IF AVAILABLE)**
"Morphology control of single-crystal InSb nanostructures by tuning the growth parameters" by Isha Verma et al; Nanotechnology Vol. 31 (2020).

NOME DEL RELATORE **THESIS ADVISOR**
Prof. Lucia Sorba

DATA **DATE**	09/10/2020	**FIRMA** **SIGNATURE**	Isha