Attività PNRR

Partenariato esteso NQSTI

National Quantum Science and Technology Institute

Sezioni INFN LNL, TO, PV, PI, RM2

Andrea Fontana, CdS PV, 05.12.2022

Attività a INFN Pavia

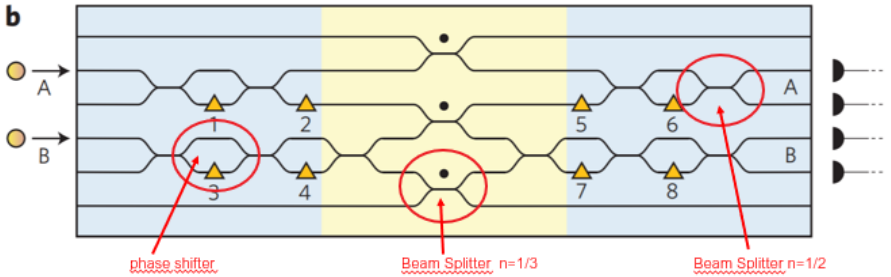
- Partecipazione allo spoke 4 "*Photonic platform for quantum technologies*" del partenariato esteso NQSTI
- Personale strutturato: Andrea Fontana 3 mesi/anno (sinergia con QUANTEP in CSN5)
- Personale da assumere: 2 anni di AdR
- Attività: simulazione, disegno e realizzazione di modulatori di polarizzazione in circuiti fotonici integrati tramite dispositivi a nanofili semiconduttori, grafene e materiali 2D.

QUANTEP in sintesi

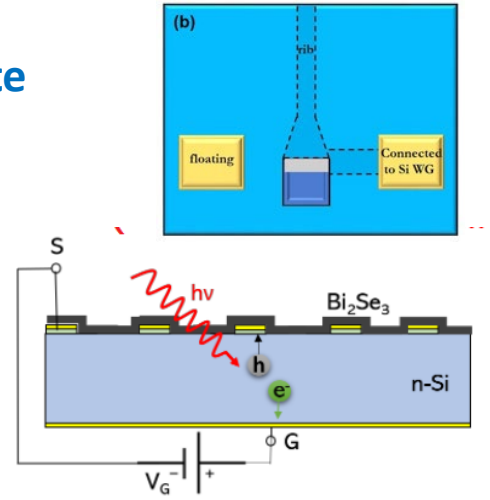
QUANtum Technologies Experimental Platform

- Call tematica di CSN5 (2021-2023, PI A. Salamon RM2)
- Goal: Sviluppo di circuiti integrati fotonici operanti in regime di singolo fotone per algoritmi di quantum computing, integrazione su silicio di rivelatori e sorgenti di singolo fotone e di circuiti per il controllo della polarizzazione
- Si possono realizzare strutture ottiche lineari con le stesse tecniche degli IC CMOS, possibilità di integrare sorgenti di singolo fotone (SPS) e fotorivelatori (SPD) tramite impiantazione

I goal: C-NOT gate

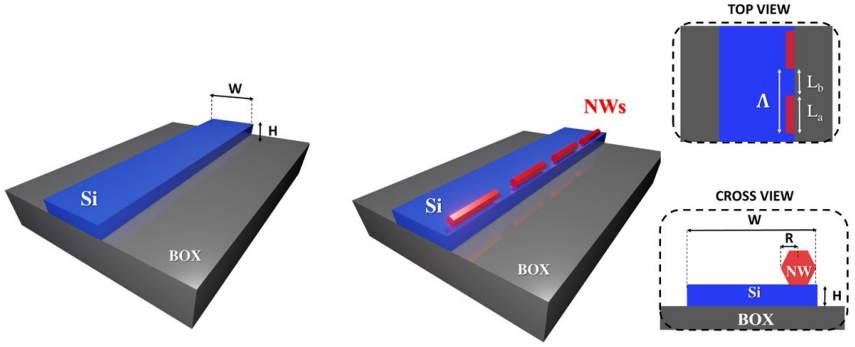


Final goal : C-NOT gate + SPD + SPS

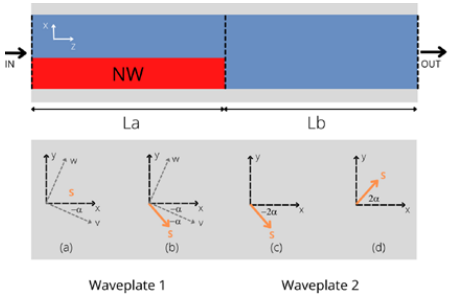


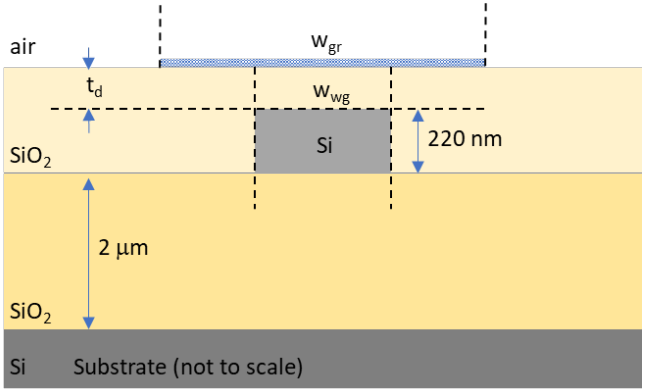
Attività computazionale a INFN Pavia

Controllo della polarizzazione attraverso nanofili o grafene/materiali 2D

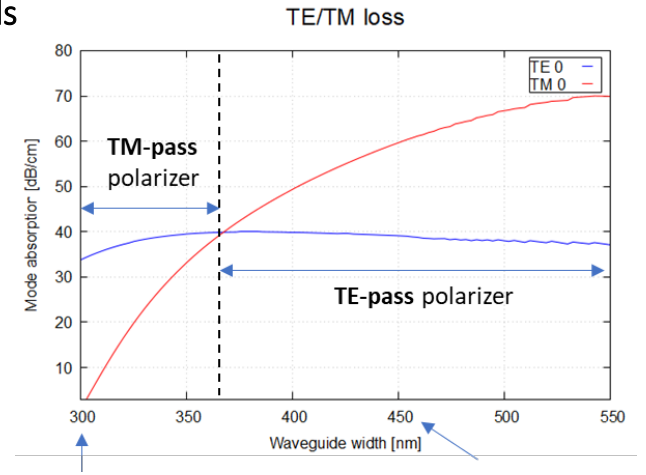


A polarization converter based on InP NWs integrated in a standard Si-waveguide was investigated. In particular, NWs having lengths L_a, are placed on the edge of a Si waveguide, at a distance L_b one from the other. According to the results of FDTD simulations, a very low number of NWs (N<6) is sufficient to convert the polarization of the propagating beam by 90%. Kaplan E, et al., Nanomaterials 2022, 12, 2438





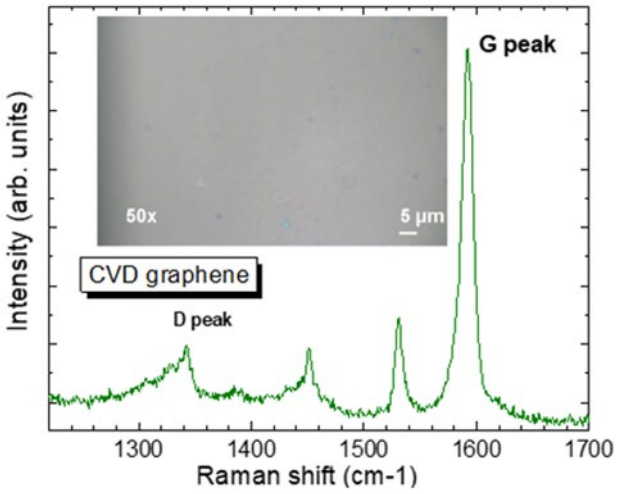
Graphene nanoribbon placed on top of a Si waveguide absorbs TE and TM modes differently. The device works switches behaviour between TE-pass or TM-pass polarizer depending on waveguide width. Cammarata S., Fontana A. et al, in press on Materials



Attività sperimentale a INFN Pavia

Graphene preparation:

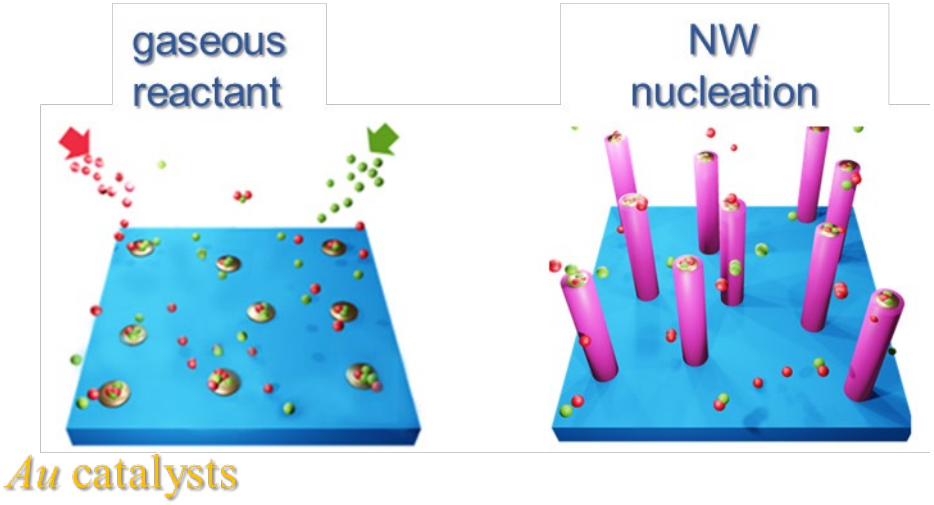
- Chemical and electro-chemical exfoliation of graphite
- Chemical vapor deposition (CVD)
- Graphene quality study by Raman spectroscopy



Z. Xia, V. Bellani, J. Sun, V. Palermo, Faraday Discussions 227, 291 (2021).

Nanowires growth by bottom-up approaches:

- Vapor Liquid Solid (VLS) process



VLS: self- assembly process, catalyzed by metal nanoparticles pre-deposited on the substrate. A liquid metal/semiconductor alloy is formed. The droplet incorporates the semiconductor precursors until supersaturation. Above supersaturation, the semiconductor starts to nucleate and precipitate, giving rise to the NWs growth.

V. Demontis et al. Nanomaterials 2021, 11(8), 2079

- **Integration** of Graphene and NWs in standard Si-Waveguides