# Artificial quantum systems based on semi-conducting quantum dots chains: towards quantum simulations in a SSH chain.

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Creating artificial quantum systems by choosing the position of atoms and their coupling is attracting as it opens to new band structure topologies. By carefully designing the artificial system, exotic phases could emerge such as topological insulating phases[1,2], Mott to superconductivty phase transition using flat band systems[3] or mimicking heavy fermion phases in a Kondo lattice[4]. Artifical systems have been realized using cold atom, polaritons and electrons[5-7]. Artificial electronic systems usually requires cryogenic temperature and nanometer scale size systems which make them incompatible with existing electronic setups. Moreover, designer artificial systems using the tip of a scanning tunnelling microscope to move atoms or molecules on a metallic surfaces, prevent any modification of the fermi level. Hence, no quantum simulations of exotic phase are possible. Patterning III-V semiconductors using e-beam lithography and etching is a promising top-down approach to create artificial systems in 2D materials by structuring it with an anti-dot lattice[8]. However, even if the Fermi level and the carrier density can be tuned, this technique suffer from high density defects after preparation, possibly hindering the emergence of topological properties. Bottom-up approaches such as Selective-Area Molecular Beam Epitaxy (SAMBE) proposes an alternative by depositing III-V semiconductors with controlled surfaces[9].

This talk will present first, the SAMBE growth of in-plane InGaAs and InSb quantum dots chains and second the characterization of the chains using scanning probe techniques. The morphology characterizations are done using atomic force microscopy (AFM) and scanning tunnelling microscopy (STM). The electronic properties are probed by tunnelling spectroscopy and finally, preliminary results on the modification of the Fermi level using side electrodes are measured using kelvin-probe force microscopy. The electronic properties will be compared to atomistic tight-binding calculations.

This preliminary work is a step towards the quantum simulation of a Su-Schrieffer-Heeger model using III-V semi-conducting quantum dots chains.

## References

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## Figures

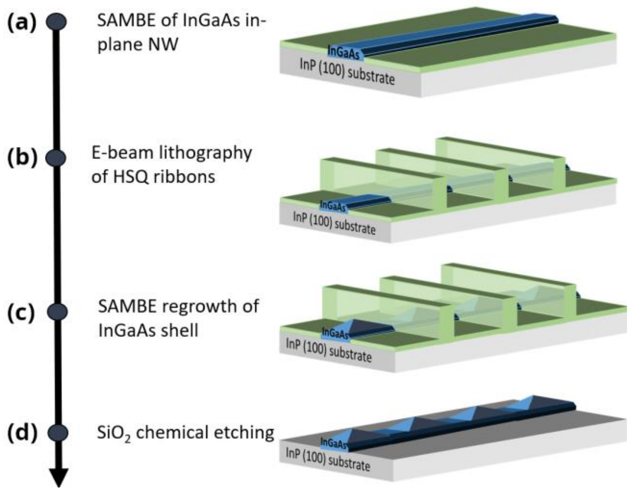


**Figure 1:** Selective-Area Molecular Beam Epitaxy step to create III-V quantum dots chains.

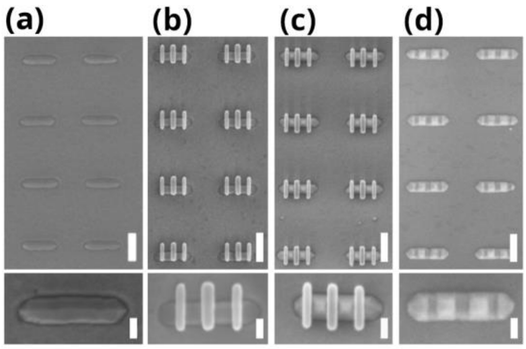


**Figure 2:** Scanning electron microscopy images of the SAMBE steps illustrated in figure 1.