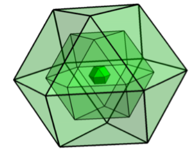
Materials Science Seminar
13/2/2024 2:30 pm
Grassano room
Sogene Building



Van der Waals epitaxy and characterization of quasi two-dimensional Ge-Sb-Te materials and heterostructures

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The advent of two-dimensional materials redefined the material science in the last decade, promising disrupting advances in many technological fields. Among the available synthesis techniques, van der Waals (vdW) epitaxy [1] ensures high quality, purity and scalability, all crucial for the integration with microelectronic technology.

Beyond the well-known phase change functionality used in non-volatile memories, the Ge-Sb-Te chalcogenide family possesses a generous variety of functional properties. As an example, the binary compound GeTe is the father of a new class of materials, namely ferroelectric Rashba semiconductors, in which ferroelectricity is used to control the spin texture at room temperature. [2] A key element for the exploitation of this rich playground is the high crystal quality achieved for the material deposited by molecular beam epitaxy (MBE) on Sb-passivated Si(111) substrates.

In this seminar, I will first give an overview on the fabrication by MBE of Ge-Sb-Te layered materials and heterostructures. [3–5] Next, I will present recent results on the vdW epitaxy and characterization of (1) GeTe-rich GST films, providing breakthrough evidence of their composition-dependent ferroelectric behavior, [6] and (2) the 1D chiral crystal tellurene, which has been integrated for the first time on silicon. Finally, I will discuss recent investigations on the crystallization and switching properties of Ge-rich GST films deposited amorphous by MBE. [7]

[1] A. Koma, "Van der Waals epitaxy–a new epitaxial growth method for a highly lattice-mismatched system," Thin Solid Films **216**(1), 72–76 (1992). [2] S. Varotto, L. Nessi, S. Cecchi et al., "Room-temperature ferroelectric switching of spin-to-charge conversion in germanium telluride," Nature Electronics **4**(10), 740–747 (2021). [3] S. Cecchi, E. Zallo, J. Momand et al., "Improved structural and electrical properties in native Sb_2Te_3/$Ge_xSb_2Te_{3+x}$ van der Waals superlattices due to intermixing mitigation," APL Materials **5**(2), 026107 (2017). [4] R. Wang, F.R.L. Lange, S. Cecchi et al., "2D or not 2D: Strain tuning in weakly coupled heterostructures," Adv. Funct. Mater. **28**(14), 1705901 (2018). [5] S. Cecchi, D. Dragoni, D. Kriegner et al., "Interplay between Structural and Thermoelectric Properties in Epitaxial $Sb_{2+x}Te_3$ Alloys," Adv. Funct. Mater. **29**(2), 1805184 (2019). [6] S. Cecchi, J. Momand, D. Dragoni et al., "Thick does the trick: genesis of ferroelectricity in two-dimensional GeTe-rich $(GeTe)_m(Sb_2Te_3)_n$ lamellae," Adv. Sci. **11**(1), 2304785 (2024). [7] S. Cecchi, I. Lopez Garcia, A.M. Mio et al., "Crystallization and Electrical Properties of Ge-Rich GeSbTe Alloys," Nanomaterials **12**(4), 631 (2022).