IBS Center for Multidimensional Carbon Materials

Prof. Luigi Colombo

University of Texas at Dallas

Solution Growth of Thin Crystalline Films

November 5
Tuesday, 2 PM

Bldg. 101
Seminar Room on the 1st floor

Tuesday Colloquium

Single crystals are at the heart of electronic devices. Silicon and germanium were perhaps the first materials to have been manufactured as a single crystal for electronic applications. Growth of single crystal germanium and silicon has been performed using the Czochralski (CZ) [1] [2], and the resulting quality of these crystals has led to the success of the transistors first and later integrated circuits. The ability to grow these high quality single crystals opened the door to the growth of many other materials, specifically multicomponent semiconductor compounds such as III-Vs, IV-VIs, and II-VIs, for many other electronic applications. However, while CZ single crystal growth worked well for Si and Ge, it was much more difficult to use for most compound semiconductors. The difficulty is due to poorer mechanical properties and difficulty in controlling stoichiometry. In order to overcome poor stoichiometry control, techniques to grow crystals in a closed system were developed, for example vertical and horizontal Bridgman techniques as well as liquid encapsulated CZ (LEC) for GaAs. A combination of application requirements, alloy control and stoichiometry control also led to the development of growth ternary and quaternary compounds (solid solutions) thin films by solution growth techniques such as liquid phase epitaxy.

Two dimensional (2D) materials have received a lot of attention over the past decade or so with the hope that they could be used to for either enabling scaling of transistors beyond CMOS or for new electronic applications. However, the preparation and growth of 2D materials is still in its infancy. What is common between the multicomponent compounds, III-Vs, IV-Vis, and II-VIs, is that 2D materials can also be grown from solutions. But rather than from liquid solutions they have been grown from solid solutions; for example graphene, bi-layer graphene, graphite and hexagonal boron nitride can be grown from M-C or M-BN solutions, M = Ni, Co, Fe, and others, using a process very much like liquid phase epitaxy. The principal difference is that the "substrate" is the solvent itself. In this seminar, I will present a comparative study of the growth and control of composition, stoichiometry, and thickness of thin films of II-VI compounds and 2D materials such as graphene, bi-layer graphene, graphite and some transition metal dichalcogenides by solution growth techniques.

References

[1] G. K. Teal and J. B. Little, "Growth of Germanium Single Crystals", *Physical Review 87*, vol. 78, p. 647, 1950.
[2] G. K. Teal and E. Buehler, "Growth of Silicon Single Crystals and Single Crystal p-n Junctions", *Physical Review*, vol. 87, p. 190, 1952.

You are cordially invited to attend!