2D Materials are attracting considerable attention for their superlative physical and chemical properties. They consist of ultra-thin sheets exhibiting covalent in-plane bonding. Following the discovery of graphene, with its unique properties, entirely new synthetic 2D materials provide access to a greater range of properties through the choice of constituents elements and substrates.

Since 2008 our teams are strongly involved in the study of different properties of these amazing materials.

**Graphene main characteristics**

- Improving the crystalline quality of epitaxially grown 2D materials is one of the main targets to preserve the unique transport properties they present as free-standing materials. This can be achieved by studying the mechanism of growth at atomic level.

- Thermal expansion and stability largely influence the properties of 2D materials which could find applications in nanoscale heat dissipation devices. Graphene is among the few materials presenting a negative thermal expansion coefficient, which can however change when supported on different substrates.

- When supported on most of the metal and oxide surface 2D shows a strongly modified atomic structure. In stead of being flat they can be corrugated. This can modified their electronic structure and their adsorption properties. The knowledge of the exact position of each atom of the large units cell in the 3D space a fundamental pre-requisite of a deep understand of all other properties.

**Electronic structure**

In several 2D materials charge carriers behave like Dirac fermions, i.e. as relativistic massless particles, with a ballistic charge transport, turning into ideal materials for nanoelectronics circuit fabrication. The uniqueness of electronic structure is reflected not only in valence, but also in core electrons. Band formation and considerable band dispersion has been observed also in the case of 1s electrons of epitaxial graphene.

**Functionalization**

In some cases 2D materials lack, however, an energetic band gap around the Fermi level in semiconductors materials, which is essential for controlling the conductivity by electronic means. A band-gap opening can be induced by the patterned adsorption of atomic species, through a process of chemical functionalization. Functionalization, with different goals, can be achieved also via atomic clusters deposition.

**Chemical reactivity**

Defect formation in the two-dimensional network during chemical processes compromises the charge carrier mobility in the materials. Understanding the mechanisms of the thermal reactions is essential for defining alternative routes able to limit the density of defects.

**Novel interfaces**

New architectures formed by 2D materials interfaces (2D metals, 2D-semiconductors, 2D-oxides, 2D-2D heterostructures) can be adopted in a large range of technological applications from nanoelectronics to energy storage.