Research Day UNICAM
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Advanced Materials in Physics at UNICAM

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- **Research groups: Material Science and Advanced Spectroscopy, Surface Science, Quantum Phenomena in Solids and Ultracold Matter**
- **Permanent staff: 11, Non-permanent staff: 16**
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Abstract

The research groups at the Unicam Physics Division have a longstanding activity in characterization and synthesis of new and advanced materials both for applications and fundamental research. Several state-of-the-art laboratory techniques are available as well as modern computer quantum simulation methods. Examples of studies are electrode nano-materials for energy-storage applications, bidimensional graphene-like materials tailored for diverse applications (supercapacitors, sensing), films of transition metal oxides for photonic applications, novel superconductors. Research is based on several financed projects an benefits of strong links and collaborations with several international institutions and large scale facilities (Synchrotron and neutron sources).

Superconductors

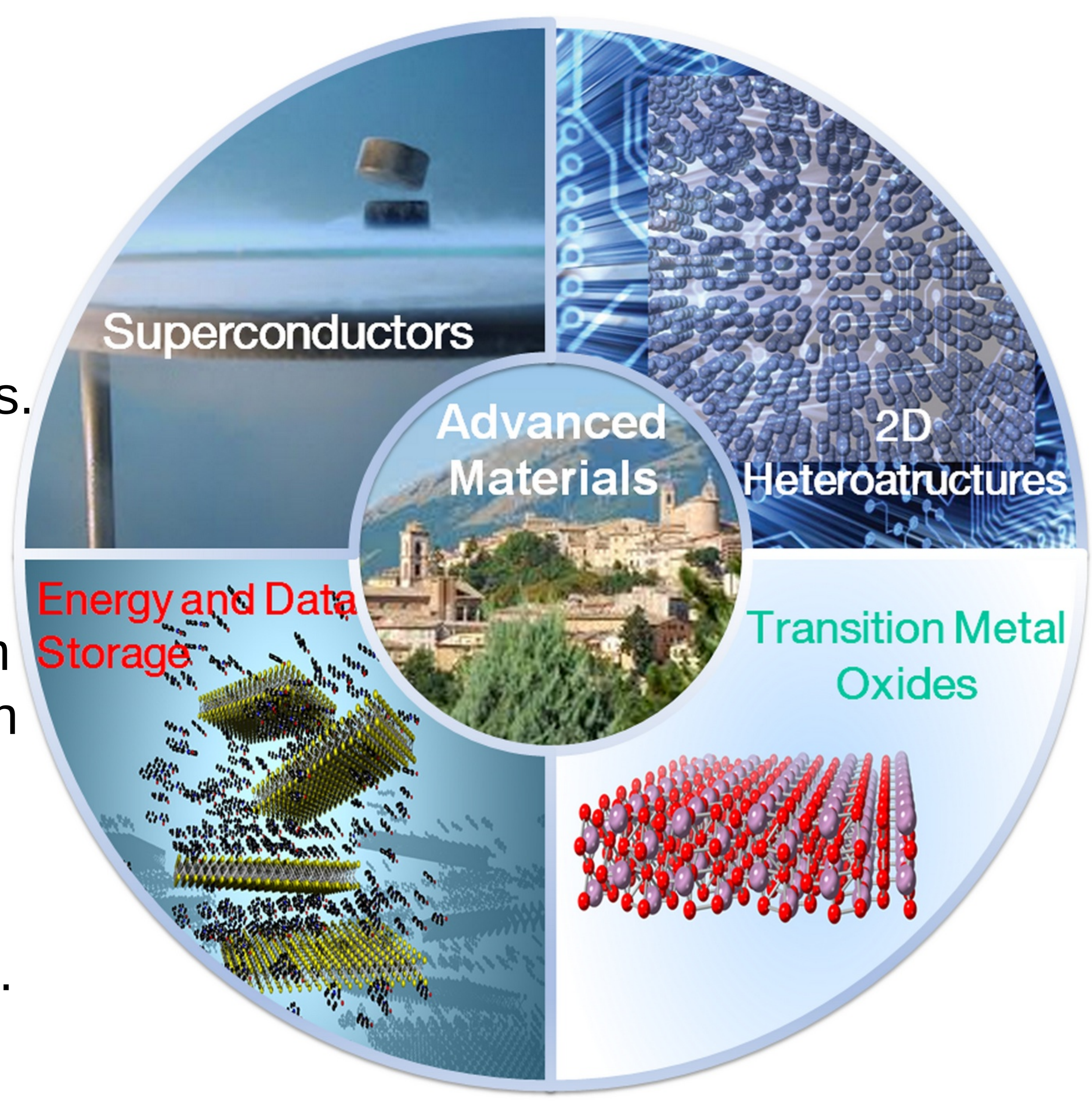
Superconducting nanofilms are tunable systems that can host a 3D–2D dimensional crossover have shown surprising evidence for metallic behavior, where the electrical resistivity is much lower than their respective non superconducting state in the zero-temperature limit. Further reduction of the disorder electron-structure dimensionality, from 2D to quasi-1D nanostructures, can generate quantum and thermal phases of order conditions, under present investigation in our Complex Quantum Matter group.

2D Heterostructures

Two-dimensional (2D) materials such as for example graphene and borophene, have attracted significant attention as distinctive platforms in both fundamental and applied contexts. Because of its polymorphism and diverse bonding geometries, borophene is a promising candidate for assembling 2D heterostructure involving the family of 2D materials. The use of borophene, a lightest 2D metal, has the unique plasmonic and correlated electron phenomena with clear implications for boron-based nanoelectronics.

Energy and Data Storage

Layered and nanostructured materials find applications in energy generation and storage, serving as active components in devices such as displays, solar cells, and batteries. Research on active materials for energy storage is particularly active. Molecular nanomagnets have slow relaxing magnetization and quantum mechanical behaviour. This research has promising applications in high density magnetic memories, qubits implementation, and as ideal systems to test quantum mechanics.



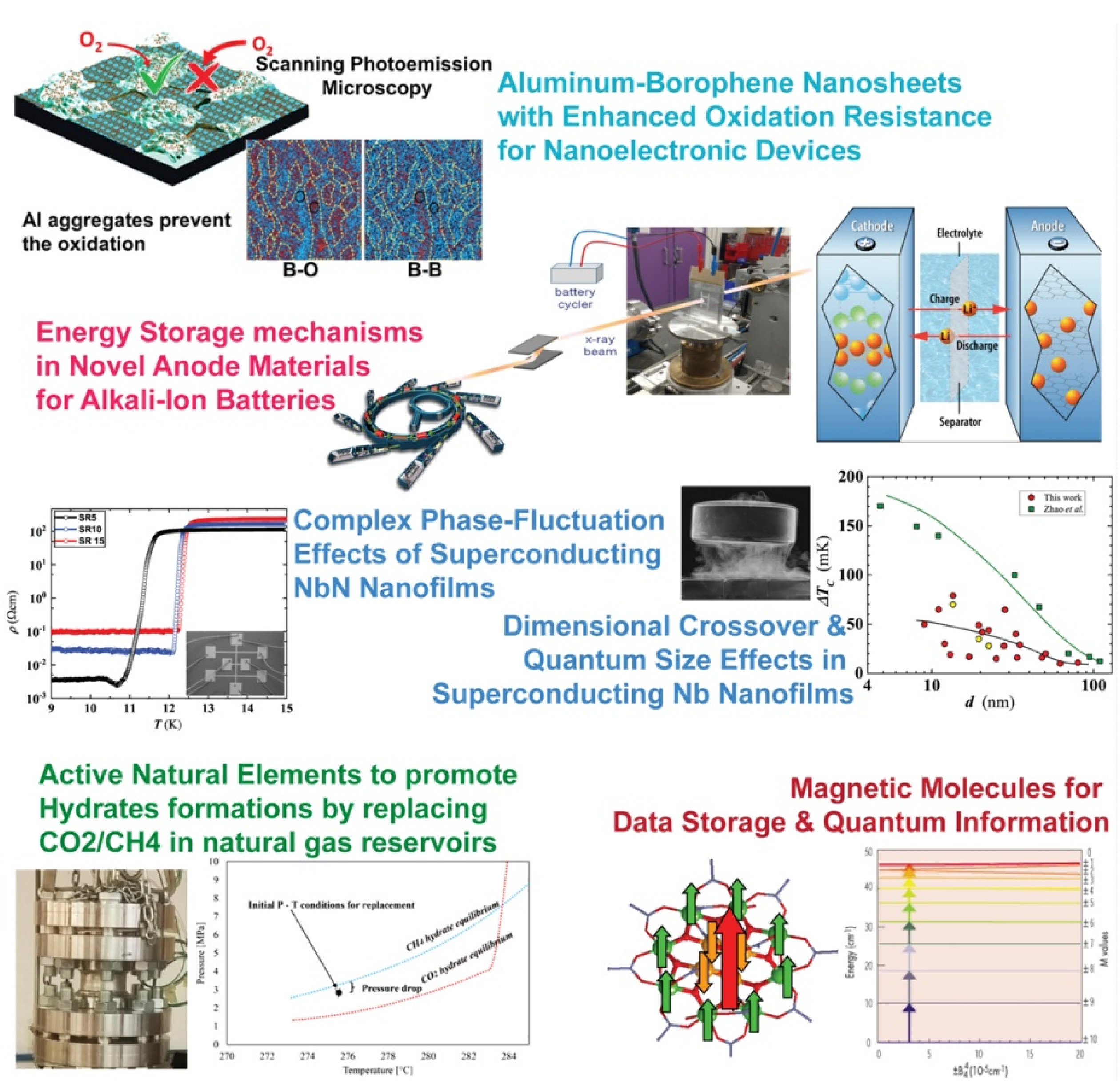
The most cutting-edge and yet extremely challenging research fields in material science currently active at the Physics Division

Transition Metal Oxides

Transition metal oxides exhibit an astonishing array of functionalities that result from a combination of the strongly polarizable metal-oxygen bond and the so-called strong correlations between the localized transition metal valence electrons. Dynamically tuning of the heightened sensitivity to external electric fields (supercapacitors), and of the strong electron correlations affecting all other valence electrons response of (superconductivity) provides a route to control of new functionalities.

Projects and funding

- Solid financial supports through national and international projects and private companies.
- Strong national and international collaboration with large scale research facilities and research centers.



Collaborations and impact

- Long standing national and international University Collaborations.
- More than 50 papers published on international journals per year.