SENSQUIP Report Summary

Project ID: 639792
Funded under: H2020-EU.1.1.

Periodic Reporting for period 2 - SENSQUIP (Scanning SQUID view of emergent states at interfaces)

Reporting period: 2016-10-01 to 2018-03-31

Summary of the context and overall objectives of the project

The emergence of novel states of matter in low-dimensional systems is one of the most intriguing current topics in condensed matter physics. For instance, interfaces between certain non-magnetic insulating oxides were shown to give rise to surprising metallic, superconducting, and magnetic states, which are still far from being understood. In SENSQUIP our goal is to capture the exciting physics that can be revealed by extremely sensitive non-invasive tracking of the local variation of electronic properties.

In SENSQUIP, our main task is to develop highly sensitive SQUID technology that enables mapping electronic states at interfaces between transition metal oxides, multiferroics, 2D superconductors, carbon nanotube structures, and topological insulators.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The main achievements during the first period can be summarized as follows:

Technological achievements:
Successful operation of a scanning SQUID in a cryogenic free system.
Improved field of view in a newly constructed scanning SQUID system.
High quality first generation of sensors.

Scientific achievements:
Tight relation between STO tetragonal domains and the local conductivity. We found that we can use structural boundaries in the substrate supporting an interface between two oxides to control the conduction at the interface.
We demonstrated a change of 100% in the resistance of small devices.
The temperature evolution of local modulations in the current over 2D domain walls in strontium titanate revealed a transition at 40K.
We identified a new and exciting electrical response to stress at domain walls in conducting oxide interfaces, indicating traces of polarity.
We developed a method to control magnetism by inducing local mechanical strain.
In order to develop a deterministic way of controlling magnetism this way, we studied the interaction between strain and nanomagnetic objects in a different system, i.e. that of vortices in a superconductor thin film. We investigated the behaviour of vortices in the presence of local physical...
contact.
Our study shows that vortices are attracted to the contact point, relocated, and remain stable at their new location.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

These results improve the understanding of basic issues in magnetism and conductivity. We gain understanding of the emergence of interface states and the ways to tune and control them.
From a practical point of view, we expect our studies to lead to the development of new devices such as oxide based electronics.
Our improvement of the planar SQUID technology will assist in positioning the SQUID as a highly useful tool for material and device characterization and will lead to new discoveries and applications.
We believe that, if successful, this project will open new horizons for investigation of electronic and magnetic phenomena in a wide range of nanoscale materials.

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