ABSTRACT FOR THE GENERAL PUBLIC

Increase in the amount of information processed by modern electronic devices requires a continuous development of new generations of faster, larger and more durable memory chips. Multiferroic vertically aligned nanocomposites (VANs) combining ferroelectric and ferromagnetic phases are a very attractive platform for developing new types of multi-bit memories operating on magnetoelectric coupling. So far, such nanocomposites have been mainly fabricated by Pulsed Laser Deposition (PLD) technique from two-phase targets comprising both ferroelectric (e.g., $BaTiO_3$/$BiFeO_3$) and ferromagnetic (e.g., $NiFe_2O_4$/$CoFe_2O_4$) materials. In this way a self-assembled vertically aligned ferromagnetic phase is embedded in a ferroelectric matrix to form an *artificial* multiferroic material (Fig. 1 **A**). Magnetic, dielectric, and structural properties of several VAN systems have been studied for nearly two decades. However, there is a lack of alternative methods for VANs fabrication, which would enable the integration of any new VAN system that cannot be obtained by means of conventional method.

In this project we aim to develop new deposition techniques for multiferroic nanocomposites. Besides preparing samples by the conventional PLD method from a two-phase target, two novel deposition pathways using reverse engineering approach will be investigated too. The new techniques involve splitting the existing one-step deposition into two separate processes, in which the self-assembled vertically aligned phase and the matrix phase are obtained independently. This provides an opportunity to optimize the deposition process parameters individually for each phase, which gives the possibility to improve their mutual integration. Our preliminary studies confirm that phase inversion is possible in VAN systems thanks to reverse engineering. This approach provides an additional degree of freedom in the design process of new multiferroic nanocomposites, thus engineering of VAN systems with controlled magnetic and dielectric properties.

Our preliminary studies showed that it is possible to deposit high-quality, epitaxial self-assembled vertically aligned $BiFeO_3$ nanostructures on monocrystalline $SrTiO_3$ substrates, providing an excellent base for deposition of the matrix material (Fig. 1 **B**). The main goal of the project is to deposit matrix material using either a subsequent PLD process (**a**) or Chemical Solution Deposition (**b**). Moreover, the architecture of VANs will be enriched with an additional thin buffer layer enabling dielectric measurements. The nanocomposites obtained will be characterized in terms of surface morphology (Scanning Electron Microscopy, Atomic Force Microscopy), atomic structure (X-ray Diffraction, X-ray absorption spectroscopy) and multiferroic properties (vibrating sample and XMCD magnetometry, dielectric studies by Broadband Dielectric Spectrometer). We aim to determine the impact of the method of nanocomposites fabrication on their structure, integration of both phases, as well as magnetoelectric performance.

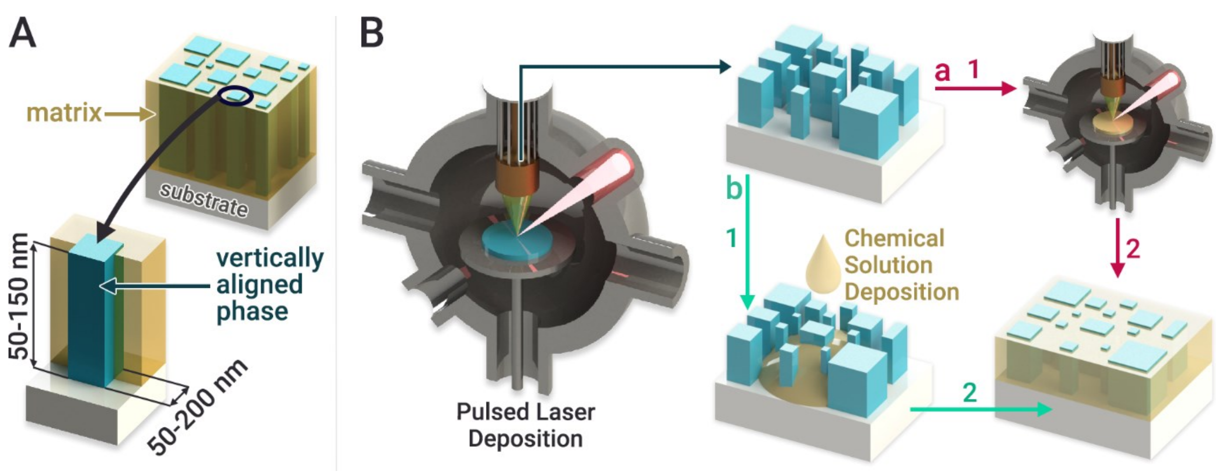

Figure 1. A) General architecture of the nanocomposites to be studied in this project, **B**) Scheme of the processes planned for nanocomposites fabrication: (**a**) two-step pulsed laser deposition and (**b**) chemical deposition from solution on a template obtained by pulsed laser deposition.