Molecular Beam Epitaxy (MBE) is a process in which thin films of a material (e.g. metal or semiconductor) are grown on a monocrystalline substrate with a crystal structure forced by the substrate. Such films, with well-defined electrical or magnetic properties, are widely used in electronics. The MBE process is identified by two terms in the method name. The word "epitaxy" from the Greek consists of: epi (ἐπί), meaning "on" and taxis (τάξις), meaning "arrangement", "order", which should be understood that the atoms (molecules) of the film are arranged on the substrate in an ordered and oriented manner, creating a thin (consisting of few atomic layers) and homogenous structure. The term "molecular beams" refers to a flux of atoms (molecules) that detached from the heated material (simply evaporated or sublimated) and deposited (and therefore returned to the solid phase) on the substrate. The adjective "molecular" says that there are so few atoms in the beam that they do not collide with each other (they also do not collide with any other atoms, because the whole process takes place in a truly "cosmic" vacuum), and therefore they travel to the substrate without any obstacles or collisions.

The atoms that have reached the substrate take part in the formation (growth) of an epitaxial layer. The structure of the layer depends primarily on its structural match to the substrate (symmetry and atomic distances). On the other hand, the growth mode (flat or island) results both from the relationship between the cohesive forces (in the film and substrate) and the film-substrate interactions, as well as from growth kinetics. Kinetic factors include the rate at which atoms reach the substrate and move (diffuse) across the surface, and the ability to overcome surface energy barriers (e.g., climb atomic steps present on any surface). Growth kinetics can be efficiently controlled by the vapor flux or substrate temperature. The project proposes a new technology of assisting the growth process by external electric or magnetic fields and stress. We expect that it will be possible to control the growth process more efficiently, as well as to tailor those layer properties that may be influenced by applied external stimuli. For example, an applied electric field can affect the surface diffusion of charged ions, and a magnetic field interacts with the atomic magnetic moments, forcing them to align with the direction of the field. As a result of stresses (e.g. mechanical bending of the substrate during the film growth), the interatomic distances can be slightly changed, which will result in compressive or tensile stress that modifies magnetic properties. The study of these phenomena and their interrelations in films and multilayer systems of metals and oxides in terms of their applications in spintronics, a new branch of electronics, will be the main subject of the project.