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Molecular Beam Epitaxy at JCNS for precise interface control in heterostructures and nanostructures

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Thin film heterostructures are essential in modern device development, offering a platform for manipulating interfacial effects. Molecular Beam Epitaxy (MBE) is an indispensable technique for the growth of high-quality epitaxial films, heterostructures, and nanostructures. It enables precise control over the composition, thickness, and structure of materials and has led to the discovery of a wide range of complex interface behaviors; including two-dimensional electron gases (2DEGs), quantum confinement, magnetism, superconductivity, and topological insulators. These interface effects result in unique electronic, optical, and magnetic properties, making them of interest for both fundamental research and technological applications.

JCNS operates two MBE systems: An oxide MBE at JCNS-2 in Jülich, and an MBE at MLZ in Garching. Both systems are available to JCNS scientists, with the Garching instrument also available to a broader scientific community through a proposal system for thin film growth.

Here we highlight ongoing projects using our MBE facilities: Variable (perpendicular magnetic anisotropy) PMA in FePd, magnetite on Nb-doped strontium titanate, Co/Pd multilayers on silica nanospheres, and multilayers of oxide and non-oxide ferromagnets and metals for skyrmion lattices and other magnetic textures. Additionally, x-ray and neutron scattering experiments on MBE-grown structures are powerful tools for investigating complex interfaces; enabling probing of structural, magnetic and electronic properties with high resolution. This can lead to new insights into the behavior of electrons, phonons, and spin waves in these systems, and help to elucidate the underlying physical mechanisms. The unique positioning of our MBE instruments provides scientists from Jülich, Garching and beyond the opportunity to grow thin film systems for neutron and x-ray experiments.

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