Designing advanced materials nanostructures using molecular beam epitaxy

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The control of nanomaterials properties by precise tuning of interfaces of ultra-thin films is of utmost importance for advanced applications. Molecular beam epitaxy (MBE), with its unmatched atomic level precision, is an ideal crystal growth technique for this application. Over the years our group has worked on this approach as a means to enhance materials properties. For example, we have designed and grown novel nanostructures based on wide bandgap II-VI semiconductors that are ideally suited for a novel high efficiency solar cell known as an intermediate band solar cell. We have also shown that the use of superlattices comprised of stacks of alternating ultra-thin layers of two topological insulator materials, grown optimally by the MBE technique, can fundamentally enhance the materials properties. The 3D topological insulators, which include Bi_2Se_3 and related compounds, are being intensely pursued for ground breaking applications such as dissipation-less transport and quantum computing. I will illustrate the potential of interface engineering by MBE based on those examples.