Fabrication of Ga_2O_3 polymorphs with ion beams

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Gallium oxide (Ga_2O_3) is a highly versatile material with applications in power electronics, optoelectronics, sensors, and battery technologies. Importantly, Ga_2O_3 may be formed in several crystalline lattices, called polymorphs, having the same chemical nature, but variable physical properties. In this project, our specific objective is to gain control over the polymorph conversion mechanisms using a recently discovered ion beam based method of disorder-induced ordering [1]. As a result, we aim to establish novel synthesis routes for Ga_2O_3 polymorph films, buried layers, and nanostructures, applying both broad-area and focused ion beams for the polymorph conversion. Perhaps the most spectacular highlight of our work so far, is the discovery of the unprecedentedly high radiation tolerance in the double polymorph Ga_2O_3 structures [2]. Moreover, we show that ion beams may enable formation of the planar multilayered polymorph repetitions [3] and laterally resolved polymorphic nanopatterns, paving the way for enhancing functionalities based on combinations of different polymorphs and their interfaces. Thus, in this paper, we present an overview of our work emphasizing on the understanding and potential applications of our data.

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