SOLID-PHASE-EPITAXY OF RUTILE-GeO2 IN MOLECULAR BEAM EPITAXY (MBE)

Wenshan Chen[1], Martin Albrecht[2], Jijun Zhang[2], Oliver Bierwagen[1]
[1] Paul-Drude-Institut für Festkörperelektronik, [2] Leibniz-Institut für Kristallzüchtung

Ultrawide bandgap (UWBG) semiconductor rutile GeO2 (r-GeO2, Eg~4.7eV) shows tremendous prospects for the next-generation power electronics as it exhibits superior thermal conductivity, carrier mobility than β-Ga2O3. Additionally, it has been predicted to have bipolar dopability.

However, the synthesis of crystalline r-GeO2 thin films is technically challenging due to the presence of competing metastable amorphous- and quartz- GeO2 and the lack of r-GeO2 substrate. Currently, thin films of r- GeO2 are grown using various methods among which MBE suffers from limited growth rates (10nm/h) due to the high vapor pressure of GeO.

Developing a new strategy for growing r-GeO2 films with suitable growth rates and high crystal quality is crucial in realizing its application potential. In this study, we create a r-GeO2 template for quasi-homoepitaxial growth of r-GeO2 films. It involves deposition of an amorphous GeO2 layer (5nm) by MBE on an r-TiO2 (110) substrate and in-situ crystallization at high temperature through solid phase epitaxy (SPE) which competes with the film desorption.

By monitoring surface evolutions (Fig. 1) during SPE using in-situ reflection high-energy electron diffraction, we observed a phase transition from amorphous GeO2 to a crystalline layer. The presence of the desired stoichiometric ratio was confirmed by X-ray photoelectron spectroscopy (Fig. 2). While crystallinity details will be further studied by Transmission electron microscope.

The creation of GeO2 crystal seeds enable templated epitaxial growth of GeO2. Our advances in SPE potentially offer a new route for synthesizing thin film r-GeO2 and provide important insights into addressing its challenging epitaxy problems.