**Creation of Material Libraries of Wide and Ultra-Wide Bandgap Conductive Oxides by Combinatorial Pulsed Laser Deposition**

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The discovery of new functional materials by exploring the phase space of multinary alloys is greatly accelerated by high-throughput experimental and computational screening methods In the realm of experimental research, high-throughput screening necessitates the utilization of sample sets that exhibit a systematic variation in material properties. These properties may include, but are not limited to, chemical composition, layer thickness, and other parameters. These can, among other methods, be realized by combinatorial pulsed laser deposition (C-PLD) enabling to create spatially addressable material libraries to be analyzed with spatially resolving physical property screening methods for high-throughput characterization [1]. The current status of C-PLD will be discussed, along with recent methodological developments.

We will illustrate the implementation of segmented PLD targets in the creation of lateral and vertical continuous composition spread material libraries (CCS-ML) for wide and ultra-wide bandgap group III sesquioxides or transition metal sesquioxides [2]. Group III sesquioxides have emerged as promising materials for applications in next-generation high-power electronic devices [3]. We address the physical properties of various polymorphs of (Al,Ga,In)2O3 as a function of cation composition.

Additionally, the physical properties of ternary α-(Me,Ga)2O3 TCOs are presented. Spatially addressable CCS-MLs of (Cr*x*Ga1-*x*)2O3, (Ti*x*Ga1-*x*)2O3, and (V*x*Ga1-*x*)2O3 were synthesized by C-PLD over a broad compositional range with high chemical resolution and experimentally investigated by high-throughput mapping using a variety of analytical methods including X-ray diffraction, energy-dispersive X-ray spectroscopy, UV-VIS transmission and spectroscopic ellipsometry measurements. For (Cr*x*Ga1-*x*)2O3 and (V*x*Ga1-*x*)2O3, phase-pure growth in the rhombohedral crystal structure was demonstrated over the entire composition range. For the (Ti*x*Ga1-*x*)2O3 CCS-ML, the α-phase was stabilized up to *x*=25%. A substantial red shift of the absorption edge with increasing *x* was found for all investigated MLs. These findings demonstrate the feasibility of the α-(Me,Ga)2O3 material systems for bandgap engineering over an exceptionally large energy range without phase-separation

A FAIR data management solution for thin film deposition and characterization data is finally presented, with a focus on the digitization of PLD process data and metadata.

[1] Holger von Wenckstern *et al*., *A review of the segmented-target approach to combinatorial material synthesis by pulsed-laser deposition*, phys. stat. sol. (b) **257**, 1900626 (2019).
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[2] A. Hassa, Holger von Wenckstern et al., *Progression of group-III sesquioxides: epitaxy, solubility and desorption*, J. Phys. D: Appl. Phys. **54**, 223001 (2021).

[3] Holger von Wenckstern, *Group-III Sesquioxides: Growth, Physical Properties and Devices*, Adv. Electron. Mater. **3**, 1600350 (2017)