Crystalline Functional Oxides Integrated with Wide Bandgap Semiconductors via Epitaxy: A Novel Platform for Multifunctional Materials Integration and Devices

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While growth of wide bandgap materials on crystalline oxides (sapphire, lithium gallate, lithium aluminate, zinc oxide and others) has become routine, growth of crystalline oxides on wide bandgap materials remains challenging and minimally explored. The potential payoff in terms of enhanced device performance, increased functionality and reliability warrants examining this option. This presentation will suggest and discuss the possibility of crystalline oxides on wide bandgap semiconductors as a potential platform for obtaining multi-functionality. With the proper choice of materials, semiconducting, ferroelectric, ferromagnetic and even superconducting properties can be obtained in a heterogeneously grown stack of materials. The desired crystalline oxide properties, potential implementation challenges and potential pitfalls will be discussed.

Finally, while efforts continue towards developing crystalline oxides on wide bandgap semiconductors for the above applications, a new approach to the old method of wide bandgap semiconductor growth on crystalline oxides has been employed. This new approach uses the electrical functionality of crystalline ferroelectric oxide substrates to "program" polarization structures into III-Nitride semiconductors. Experimental results will be given showing how ferroelectric crystalline oxides can be used to construct new "polarization engineered" devices using wide bandgap epitaxy on poled substrates. Such structures offer promise for never before realizable devices as well as studies of interesting polar-domain interface physics. Various electronic/optoelectronic devices resulting from this new technology will be proposed, along with demonstrations of a small device subset.