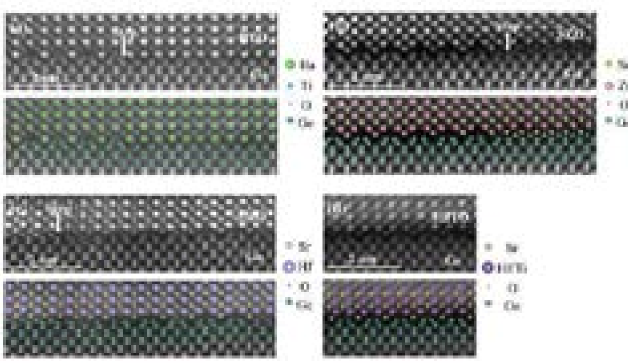
John G. Ekerdt et al., Res. Rev. J Mat. Sci. 2017, 5:5
DOI: 10.4172/2321-6212-C1-005

Atomic layer deposition routes to monolithic integration of crystalline oxides on semiconductors

John G. Ekerdt, Shen Hu, Edward L. Lin, Pei-Yu Chen, Agham Posdadas and **Alexander A. Demkov**
University of Texas at Austin, USA

The semiconductor industry faces new challenges in the sub-10 nm era as scaling will no longer dominate performance improvement. New materials provide opportunity to improve performance with minimal architectural overhaul. For example, high-mobility channels of Ge and III-V semiconductors can provide both lower power consumption and faster computing speeds. In certain applications significant advantages are gained by monolithic integration of the oxides directly on the substrates that will host other devices/components. Perovskite oxides offer a wide range of properties from high-k to multiferroic affording the device designer a suite of possibilities, and are particularly important due to their common structure and lattice-matching with common semiconductors. The gallium nitride device applications will require a dielectric to passivate the nitride surface. Atomic layer deposition (ALD) allows for growth of perovskite oxides and rare earth oxides in a chemical deposition process that is scalable and manufacturable. It is possible to grow crystalline perovskites directly on Ge(001) by ALD. Using this approach we have been able to deposit STO, $BaTiO_3$, $SrHfO_3$, $Sr(HfTi)O_3$, and $SrZrO_3$ directly on Ge(001). We will discuss the growth and properties of the perovskite layers directly on Ge(001), and will discuss the interface chemistry and structure that likely controls the interfacial reactions that allow for crystalline film formation. It is also possible to grow crystalline rare earth oxides directly on GaN(0001) by ALD. We report approaches to growing crystalline, hexagonal and cubic Er_2O_3 on wurtzitic gallium nitride, GaN (0001). As with growth of perovskites on Si and Ge, atomically-thin intermetallic compounds comprised of Group 1 or 2 elements and Group 13-15 elements to facilitate wetting and direct the crystalline growth, in this case the [111] growth direction of the oxides on GaN (0001). This talk will describe the growth, structures and properties of crystalline oxides grown by ALD.



HAADF STEM images showing the interface of BaTiO3 (BTO) (a), SrZrO3 (SZO) (b), SrHfO3 (SHO) (c) and SrHf0.55Ti0.45O3 (SHTO) (d) films grown by ALD on Ge (001) substrates. White arrows mark the position of a single layer Ge surface step. Structural models below each image illustrate the interface structure in particular showing the change in periodicity of the Ge (001) substrate surface and the location of the Ba (or Sr) atomic columns between the Ge dimers. S. Hu et al., J. Chem. Phys.146, 052817 (2017).

Biography

John G. Ekerdt is Associate Dean for Research in Engineering and the Dick Rothwell Endowed Chair in Chemical Engineering at the University of Texas at Austin. He has more than 300 refereed publications, two books and three book chapters, and seven U.S. patents. He has supervised 48 Ph.D. and 8 M.S. students. Current research interests focus on the surface, growth and materials chemistry of metal, dielectric and perovskite films and nanostructures. The work seeks to: 1) develop and understand the reactions and chemistry that control nucleation and growth of films and nanostructures, and 2) understand the properties of these materials and relate the properties to structure, bonding and growth.

ekerdt@utexas.edu

Notes: