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High-performance, heteroepitaxial, nanolaminate device layers on single-crystal-like, artificial substrates and controlled self-assembly of nanostructures within device layers for wide-ranging electrical and electronic applications

For many energy and electronic applications, single-crystal-like materials offer the best performance. However, in almost all cases, fabrication of single-crystal form of the relevant material is too expensive. In addition, for many applications, very long or wide materials are required, a regime not accessible by conventional single-crystal growth. This necessitates the use of artificially fabricated, large-area, single-crystal-like substrates suitable for heteroepitaxial growth of the relevant advanced material for the electronic or energy application in question. In this talk, details of the fabrication of such substrates will be provided. Heteroepitaxial growth of nanolaminate multilayers and devices on such substrates using a variety of deposition techniques such as pulsed laser ablation, sputtering, e-beam evaporation, MBE, MOCVD, and chemical solution deposition will be reported upon. Application areas that have been demonstrated via the use of such artificial substrates include – oxide high-temperature superconductors, semiconductor materials (Si, Ge, GaAs, CdTe, Cu_2O), ferroelectrics ($BaTiO_3$), multiferroics ($BiFeO_3$), etc. In addition, strain-driven self-assembly of second phase nanomaterials at nanoscale spacings has been demonstrated within device layers. Control of heteroepitaxy in lattice-mismatched systems and the effects of strain on self-assembly will be discussed. Such heteroepitaxial device layers on large-area, single-crystal-like artificial substrates are quite promising for a range of electrical and electronic applications.

Biography

Amit Goyal is the director of the multidisciplinary and interdisciplinary RENEW (Research & Education in Energy, Environment & Water) Institute at SUNY-Buffalo in Buffalo, New York. He is also Empire Innovation Professor at SUNY-Buffalo. Previously he was a UT-Battelle corporate fellow, a Battelle Distinguished Inventor and an ORNL Distinguished Scientist at Oak Ridge National Laboratories in Tennessee. He was also the Chair of the UT-Battelle-ORNL Corporate Fellow Council. Goyal is one of the leading scientists world-wide in the field of advanced electronic and energy materials including high temperature superconductors. He has over 85 issued patents. He also has over 350 publications. In 2009, an analysis of citations and papers published worldwide in the last decade in the field of high-temperature superconductivity, in 1999–2009, conducted by Thomson Reuters Essential Science Indicators (ESI), ranked him as the most cited author worldwide during those years. He is a member of the National Academy of Engineering and the National Academy of Inventors.

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