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NANOSCIENCE COLLOQUIUM

Semiconductor Nanowires: Synthesis, Fundamental Properties, and Novel Device Concepts

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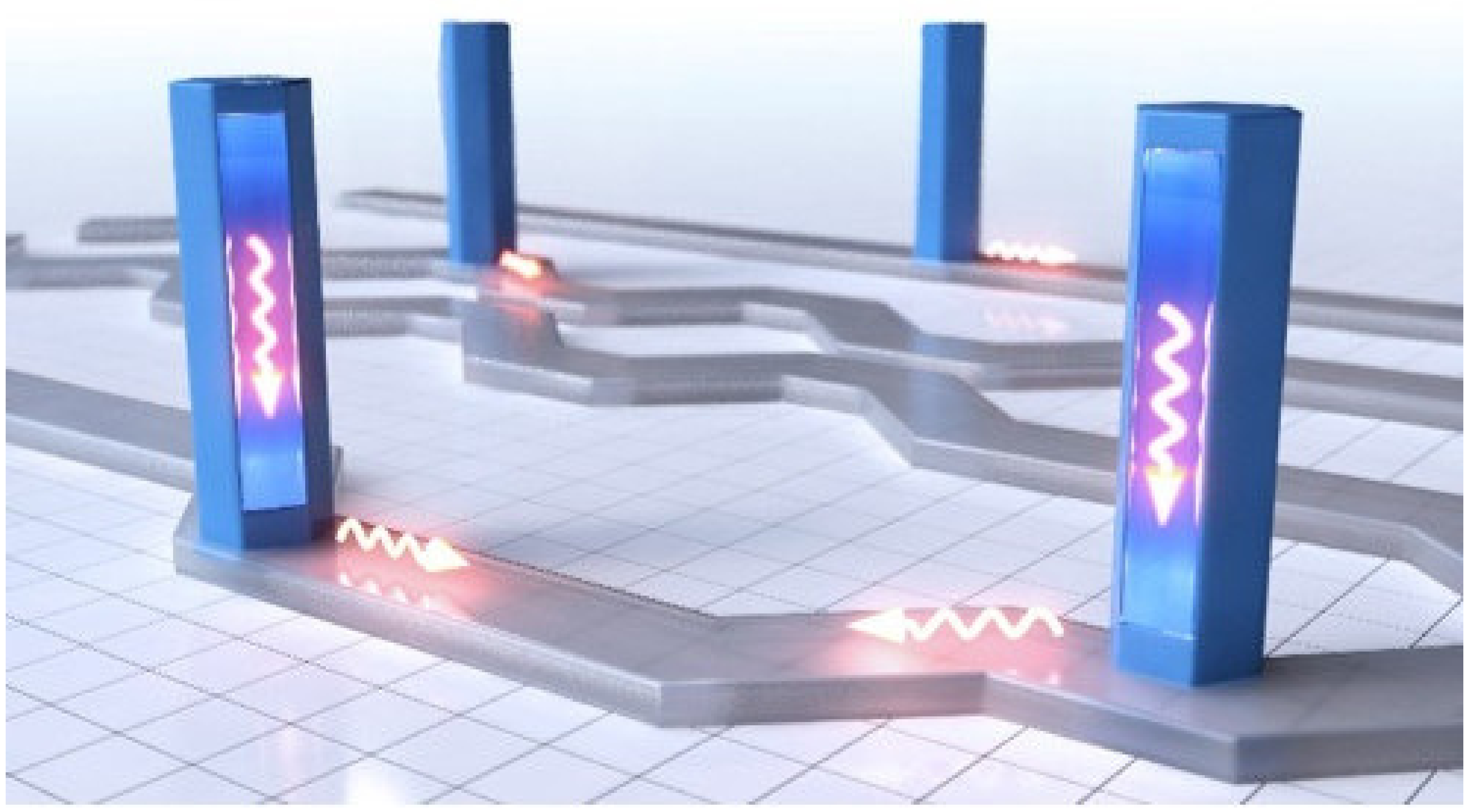
Abstract: Semiconductor nanowires (NW) comprise a unique class of low-dimensional nanostructures with very high aspect ratio, offering many interesting features in material design, novel funda-ment¬al properties and advanced device applications, particularly in information technology, energy conversion & sensing. Remarkably, their inherent one-dimensional (1D) geometry presents an ideal structure to realize complex heterostructures & further offers strong electronic, photonic and phonon confinement allowing precise tailoring of physical properties.



In this talk I will highlight the current state-of-the-art in the synthesis of III-V-semi¬con¬ductor NWs on Si, explore their fundamental structural, electronic and size quantization properties, and demonstrate their functionalities in ultra-scaled NW-based electronic switches and mono-lith¬ically integrated nano¬lasers on Si. Focusing mostly on the prototypical GaAs-AlGaAs core-shell NW model system, I will demonstrate the possibility to realize optically highly active NWs even at extreme size limits below 10 nm as well as NW-quantum dot (QD) based single photon emitters enabled by the strong quantum confinement effects. The GaAs-AlGaAs core-shell NW heterostructures represent further a very useful system for nano¬lasers coupled to Si photonic hardware. Here, we will see how through careful design one can realize the first NW lasers on Si with low threshold, ultrafast emission properties, and direct coupling of lasing emission to Si waveguides. Finally, I will present also the potentials of ultra-scaled GaAs-AlGaAs core-shell NWs for steep-slope electronic switches using high-mobility modulation-doped NW field effect transistors, and further reveal signatures of quantized transport properties. These systems are also prominent candidates for thermoelectrics due to their 1D-like subband structure and carrier transport in channels free of surface scattering.

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