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Self-assembled, vertically aligned, epitaxial nanoscale $p-n$ heterojunctions for thin film based photovoltaic applications DANIELA F. BOGORIN, TOLGA AYTUG, PARANS M. PARANTHAMAN, ANDREW A LUPINI, ADAM RONDINONE, KYLE WINTERS, Oak Ridge National Laboratory, Oak Ridge, TN 37831, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN 37831 TEAM — Using *rf*- sputtering technique we have exploited phase-separated self-assembly and developed epitaxial, nanostructured composite films composed of phase separated, and vertically oriented $p-n$ interfacial nanocolumns of Cu_2O (p type; 2eV bandgap) and TiO_2(n type; 3.2 eV bandgap). The characteristic band gaps of these phases allow extension of the solar capture from ultraviolet to a visible wavelenght. The composite films were grown on perovskite substrates and exhibit single crystalline epitaxy in both phases. We have investigated crystalline structure, interfacial quality and optical properties of the nanopillar arrays using XRD, TEM, SEM, AFM, and optical absorption techniques. Here, we show nearly complete atomic order at Cu_2O-TiO_2 interface (i.e., $p-n$junction) and an absorption profile that captures a wide range of solar spectrum extending from ultraviolet to visible wavelengths. Compared to layered thin film architectures, the use of such vertically aligned nanostructures in solar cells can promote cost-effective fabrication of high efficiency PV devices by providing low defect concentrations, improved absorption and light trapping capabilities, and increased minority carrier diffusion lengths.

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