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Periodically Diameter-Modulated Semiconductor Nanowires for Enhanced Optical Absorption MINJEE KO, SEONG-HO BAEK, BOKYUNG SONG, JANG-WON KANG, CHANG-HEE CHO, Daegu Gyeongbuk Institute of Science and Technology, DEPARTMENT OF EMERGING MATERIALS SCIENCE TEAM, DIVISION OF NANOENERGY CONVERGENCE RESEARCH COLLABORATION — Semiconductor nanowires could enable efficient light trapping, thereby giving rise to enhanced optical absorption at specific resonance wavelengths depending on their size. In this study, we introduce a novel approach to enhancing optical absorption by modulating the diameters of nanowires, in which the diameter changes periodically in a sinusoidal manner along the axis of the wire. We found that the absorption of diameter-modulated silicon nanowire exhibits stronger and multiple resonance peaks compared to simple cylindrical nanowire, leading to the enhanced absorption over a broad spectral range. To understand the resonance modes that are responsible for the enhanced absorption, we analyzed leaky guided modes in the diameter-modulated nanowire through finite-difference time-domain (FDTD) simulations and analytical calculations. Our finding is that the stronger and multiple resonances originate from substantial transverse components of the Poynting vector, giving rise to enhanced coupling with higher-order mode resonances by means of the periodically modulated diameter. Our results suggest that unique capability of semiconductor nanowires with periodically modulated diameters offers enhanced broadband absorption beyond that of simple nanowire geometries.

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