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Photon transport and localization in optical superlattices PIN-CHUN HSIEH, Columbia University, CHUNG-JEN CHUNG, National Cheng Kung University, Taiwan, JAMES MCMILLAN, Columbia University, MIN-AN TSAI, Industrial Technology Research Institute,Taiwan, MING LU, Brookhaven National Laboratory, NICOLAE PANOIU, University College London, UK, CHEE WEI WONG, Columbia University — One of the most daunting challenges in optics is to control the flow of light at the mesoscopic scales, the main impediment being the limitations imposed by diffraction. Here we examine the photon transport and collimation in optical superlattices, involving transverse guided resonances and disorder-induced localization. First we demonstrate a new mechanism for beam collimation through cascaded tunneling of guided resonances in the superlattices. Near- and far-field measurements, along with precision group delay measurements, elucidate the coupled transverse guiding modes for the electromagnetic propagation, supported by large-scale numerical modeling. Second, with pre-designed structural disorder in random heptagonal, square and triangular scattering sites, we uncover the mechanism of disorder-induced transverse localization in the chip-scale optical superlattices. Arrested spatial divergence is captured in the power-law scaling, along with exponential and asymmetric mode profiles, and increasing collimation bandwidth for increasing disorder over 4,000 scattering sites. With increasing structural disorder, we observe the crossover from cascaded guided resonances into transverse localization modes beyond the ballistic and diffusive transport of photons.

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