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Optical bandgap determination of ultrathin amorphous films and superlattices STYLIANOS SIONTAS, PEI LIU, Brown University, PAOLO LONGO, Gatan Inc., ALEXANDER ZASLAVSKY, DOMENICO PACIFICI, Brown University — Quantum size confinement effects determine the optical bandgap of ultrathin <5 nm amorphous films and superlattices. Although widely used, the standard experimental approach of combining normal-incidence reflectance and transmittance measurements with a single-pass absorption model may not always provide reliable results. By using ultra-thin amorphous germanium (a-Ge) layers down to $d = 2$ nm thickness as an experimental platform, we show that a multiple-reflection interference model is necessary to provide a more accurate extraction of the absorption coefficient. We also compare the two most frequently-used analytical models (Tauc and Cody) used to extract the optical bandgap from the measured absorption coefficient and clearly demonstrate that the Cody model provides a more reliable bandgap dependence on d. Finally, we apply our proposed method to experimentally determine the optical bandgap of a-Ge/SiO_2 superlattices with alternating layers of a Ge and SiO_2 ranging from 2 to 30 nm. Such superlattice structures enable additional control over the optical bandgap that may prove useful for the fabrication of high-efficiency photodetectors and solar cells in the optical and near-infrared spectral ranges.

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