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Infrared Refractive Index of Silicon: Parity and Sum-Rule Tests[1]

WILLIAM KARSTENS, Saint Michaels College, MITIO INOKUTI[2], Argonne National Laboratory, DAVID Y. SMITH, University of Vermont and Argonne National Laboratory — We have resolved conflicting reports for the IR refractive index of silicon using general considerations of linear response theory. We find that use of unphysical series expansions in the analysis of channel spectra has been a significant source of systematic error. Recognition that the index is an even function of photon energy is crucial for analysis of these measurements and clarifies data presentation. In the region of high IR transparency of elemental semiconductors, the index may be expanded in a rapidly convergent Taylor series. Coefficients of terms in the $(2n)^{th}$ power of energy are proportional to the $(2n+1)^{th}$ inverse moment of the electronic absorption spectrum. In the favorable case of intrinsic Si, the electronic absorption is sufficiently well known that independent values of the intercept, slope and curvature of plots of index *vs.* the square of photon energy may be calculated. Index data sets with parameters significantly different from these suffer from systematic errors or refer to impure samples. Using these parity and sum-rule tests we have prepared a composite index data set for intrinsic silicon that represents a best fit to reliable measurements from microwaves to the visible. Applications to germanium and diamond will be discussed.

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