Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Critical Dispersion-Theory Tests of Silicon's IR Refractive Index[1]

WILLIAM KARSTENS, Saint Michael's College, D. Y. SMITH, University of Vermont and Argonne National Laboratory — Silicon strongly absorbs both visible and UV light, but is highly transparent in the IR. Hence, it is a common choice for infrared windows and lenses. However, optical design is hindered by literature index values that disagree by up to 1%. In contrast optical-glass indices are known to 0.01% or better. The most widely available silicon IR indices are based on bulk measurements using either Snell's-Law refraction by a prism or channel-spectra interference of front- and backsurface reflections from a planar sample. To test the physical acceptability of these data, we have developed criteria based on a Taylor expansion of the Kramers-Kronig relation for the index at energies below strong inter-band transitions. These tests require that the coefficients of the series in powers of energy squared must be positive within the region of transparency. This is satisfied by essentially all prism measurements; their small scatter arises primarily from impurities and doping. In contrast, channel-spectra data fail in the second and third coefficients. A review of the experimental analysis indicates three problems besides purity: incorrect channel number arising from a channel-spectra model that neglects spectrum distortion by the weak lattice absorption; use of a series expansion of mixed parity in photon energy to describe the even-parity index; and use of an incorrect absorption energy in the Li-Sellmeier dispersion formula. Recommendations for IR index values for pure silicon will be discussed.

[1]Supported in part by the US Department of Energy, Office of Science, Office of Nuclear Physics under contract DE-AC02-06CH11357.

David Y Smith
University of Vermont and Argonne National Laboratory

Date submitted: 25 Oct 2016 Electronic form version 1.4