Accurate and wide-dynamic-range optical power evaluation with a silicon photodiode

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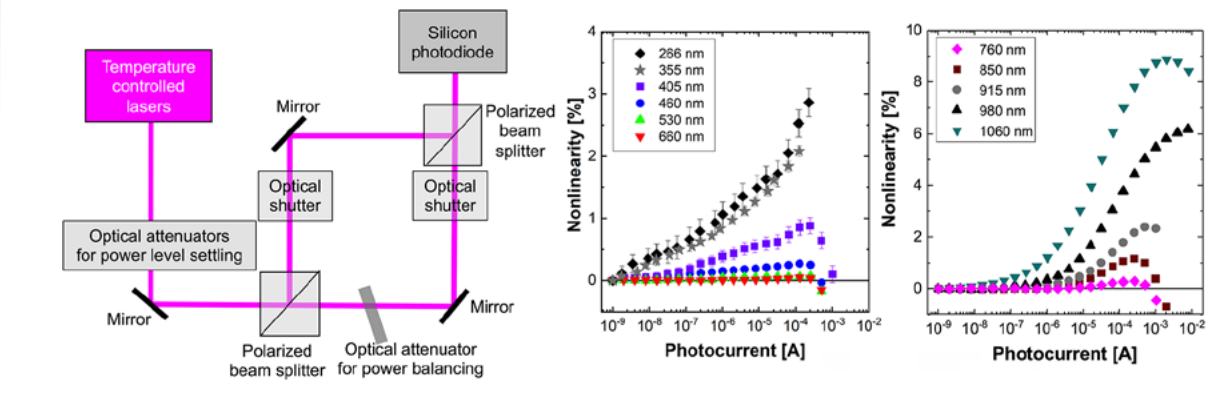
Silicon (Si) photodiodes (PDs) are widely used as optical sensors because of their ability to cover the ultraviolet-to-near-infrared wavelength range and their dynamic optical power range of more than six orders of magnitude. A Si PD ideally shows a linear response at any optical power, i.e., its photoelectric response is proportional to the incident power. However, actual PDs exhibit characteristic nonlinear responses that depend on the incident wavelength. This nonlinearity may affect the accuracy of optical measurements using Si PDs in areas such as photometry, radiometry, and colorimetry.

NMIJ developed an accurate nonlinearity evaluation system for Si PDs in the ultraviolet to near-infrared range. We evaluated the spectral nonlinearity of different types of Si PDs and found that the nonlinear behavior depends strongly on the incident wavelength and varied greatly depending on the PD type. These experimental results were well explained by theoretical models considering carrier dynamics, making it possible to predict the nonlinear behavior from some device parameters and obtain a correction factor for the measured power responsivity at different power levels.

Reference: M. Tanabe, *Meas. Sci. Technol*. **35**, 022001, 2024, https://doi.org/10.1088/1361-6501/ad080c



Nonlinearity evaluation system for Si PDs (left), and experimentally measured nonlinearities in the ultraviolet and visible ranges (middle) and in the near-infrared range (right).