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# Correlation of light–electron interactions and structural changes in fused regions of polymer optical fibers for optical sensing applications

[Laser Physics](#) • Article • [Open Access](#) • 2026 • DOI: 10.1088/1555-6611/ae4194 [Amin, Al](#)<sup>a,b</sup>; [Yusof, Muhammad Khudhori Mohd](#)<sup>a,b</sup>; [Azahan, Siti Nurul Fatimah](#)<sup>a,b</sup>; [Farid, Sabrina Mohd](#)<sup>a,b</sup>; [Zulkifli, Mohd Zamani](#)<sup>a,b</sup> <sup>a</sup> Kulliyah of Science, International Islamic University Malaysia, IIUM Photonics and Quantum Centre, Pahang, Kuantan, 25200, Malaysia[Show all information](#)

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## Abstract

Polymer optical fibers (POFs) are increasingly utilized in optical sensing due to their mechanical flexibility and low fabrication cost. However, the effect of thermal fusion on their photophysical properties remains inadequately understood. This study investigates the correlation between fusion-induced structural modifications and light–electron interactions in step-index POFs fabricated from polymethyl methacrylate (PMMA). Fiber segments were subjected to controlled thermal fusion. Comprehensive optical characterization was performed on fused and non-fused fibers, including UV–VIS absorbance, transmission, and reflection spectroscopy, fluorescence emission analysis, and optical band gap estimation via Tauc plots employing the Kubelka–Munk function. Fused fibers exhibited significantly increased absorbance, decreased transmission, and enhanced reflection relative to controls, indicative of refractive index modulation and defect formation at the fused

interface. Fluorescence spectra revealed a pronounced red shift from approximately 632 nm to 651 nm, accompanied by a strong enhancement in emission intensity, indicative of defect-assisted radiative recombination pathways formed during fusion. These fusion-induced optical responses enable the fused region to function as a localized sensing element in multiple configurations. Intensity-modulated sensing can be realized through fusion-induced absorption and scattering changes that respond to external perturbations such as mechanical deformation or refractive index variations. Fluorescence-based sensing modes may exploit defect-assisted emission intensity and wavelength shifts under fixed optical excitation, while enhanced reflectance at the fused junction supports reflectometric sensing schemes sensitive to surface or interfacial changes. These findings establish a direct relationship between thermal processing and photonic behavior in PMMA-based POFs, providing a physically grounded framework for the development of tunable POF sensing platforms. © 2026 Astro Ltd. All rights, including for text and data mining, AI training, and similar technologies, are reserved. This article is available under the terms of the IOP-Standard License.

## Author keywords

defect state formation; fused region characterization; light–electron interactions; optical band gap narrowing; optical sensing; polymer optical fiber (POF); Tauc plot (Kubelka–Munk method)

## Indexed keywords

### Engineering controlled terms

Defect states; Fiber optic sensors; Fluorescence; Optical correlation; Optical fiber fabrication; Plastic optical fibers; Red Shift; Surface defects

### Engineering uncontrolled terms

Band gap narrowing; Defect state; Defect state formation; Electron's interactions; Fused region characterization; Kubelka-munk methods; Light–electron interaction; Optical band gap narrowing; Optical bands; Optical sensing; Polymer optical fiber; Polymer optical fibre; State-formation; Tauc plot (kubelkum–munk method); Tauc plots

### Engineering main heading

Refractive index

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