Breakthrough in Luminescence Thermometry-Supersensitive Emission Line Shift of Whispering Gallery Modes in Rhodamine B-Doped Cellulose Fiber Microresonators

K. Soler-Carracedo[1,#], P. Woźny[1], M. Skwierczyńska[1], I. R. Martin[2], P. Kulpiński[3], M. Runowski[1]

[1] Faculty of Chemistry, Adam Mickiewicz University, Poznań 61-614, Poland
[2] Departamento de Física, Instituto de Materiales y Nanotecnología (IMN), Universidad de La Laguna, San Cristóbal de La Laguna E-38200 Santa Cruz de Tenerife, Spain
[3] Department of Mechanical Engineering, Informatics and Chemistry of Polymer Materials, Lodz University of Technology, Łódź 90-924, Poland

The development of optically responsive materials for remote sensing is essential for modern photonic technologies. Here, cellulose microfibers doped with Rhodamine B were fabricated via N-methylmorpholine N-oxide spinning and investigated for optical thermometry. Spectroscopic analysis confirmed successful dye incorporation and strong emission behavior, consistent with previous reports on dye-doped polymer systems. The cylindrical geometry of the fibers supports the phenomenon known as whispering gallery modes (WGMs) [1], which, observed using a confocal setup with 532 nm excitation, leads to sharp, structured emission spectra in agreement with established WGM microresonator studies [2]. These WGMs exhibit exceptional sensitivity to temperature due to the negative thermo-optical coefficient of the cavity, producing an unprecedented blue shift of ~0.47 nm K^{-1}, highest value reported for such kinds of optical thermometers based on the WGMs. The system achieves a high temperature resolution of ~0.17 K, demonstrating its potential as a highly sensitive optical thermometer.

[1] Oraevsky, A. N. (2002). Whispering-gallery waves. Quantum electronics, 32(5), 377-400.
[2] Paz-Buclatin, F.; Ríos, S.; Martín, I. R.; Martin, L. L. Fluorescence Intensity Ratio and Whispering Gallery Mode Techniques in Optical Temperature Sensors: Comparative Study. Opt. Mater. Express 2019, 9 (10), 4126.

corresponding author: kevsol@amu.edu.pl