Development and characterization of nanoparticle-infused glass rods prepared via the micro-pulling-down method

Herbert Kindl[1,2], Karol Bartosiewicz[1], and František Zajíc[1]

[1]*Institute of Physics of the Czech Academy of Sciences, Cukrovarnická 10/112, Prague, 162 00, Czechia*

[2]*Department of Inorganic Chemistry, University of Chemistry and Technology, Prague (UCT Prague), Technická 5, Prague 166 28, Czech Republic*

This work focuses on the development of glass rods infused with various nanoparticles as a promising new radioluminescent material with fast timing. The motivation for preparing such material was to mitigate quenching effects caused by volume phenomena typically observed in bulk luminescent materials. This can be achieved by embedding crystalline nanoparticles of a luminescent material into a low-melting-point matrix. This strategy effectively reduces the impact of total internal reflection, which traps emitted photons within the crystal lattice and restricts their extraction. As light emission occurs independently from each nanoparticle within the system, this approach can enhance luminescence speed and efficiency. A method chosen for the preparation of these nanocomposites was the micro-pulling-down method (μ-PD). During the μ-PD process, the melt is pulled through a capillary in which microscopic cavities occur due to high pulling rates. As these cavities collapse, they release shock waves, effectively separating agglomerated nanoparticles. The main goal of this work was to optimize the growth process by customizing the hot zone and to determine the effects of different temperature and pulling rate programs on rod shape and nanoparticle distribution. Furthermore, samples will be characterized using XRD, SEM/EDS and optical, luminescent and scintillation properties will be estimated.