

Nanoparticles in optical fibers: a stimulating oxymoron

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Since the ground-breaking discovery done in the 1960s by Charles K. Kao, the perfect glass, i.e. the most transparent glass, drives the development of optical fibers. Meanwhile, to overcome some limitations imposed by the silica glass, one recent strategy consists of embedding nanoparticles in the core of the optical fiber [1]. However, nanoparticles and silica glass have different refractive indices, leading to light scattering. To avoid this issue, it was required to prepare the smallest nanoparticles. Despite the promising interest for such fibers, scarce results were published over the last 20 years. During this presentation, we will discuss on the role of the drawing step as an efficient top-down fabrication process to control the shape and the size of the nanoparticles. Then, we will analyze the chemical composition of nanoparticles demonstrating that we need to reconsider the doxa "the smallest, the better" [2]. We also present some results taking advantage of light scattering to promote new fiber sensors [3]. All these results give new insights to the development of nanoparticles-containing optical fibers.

References:

- [1] A. Veber *et al.*, Nano-structured optical fibers made of glass-ceramics, and phase-separated and metallic particle containing glasses, *Fibers*, Vol. 7, **2019**, 105.
- [2] W. Blanc *et al.*, Compositional changes at the early stages of nanoparticles growth in glasses, *J. Phys. Chem. C*, Vol. 123, **2019**, 29008-29014.
- [3] D. Tosi *et al.*, Enhanced backscattering optical fiber distributed sensors: tutorial and review, *IEEE Sensors*, accepted, doi; 10.1109/JSEN.2020.3010572.