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Multimodal characterization of broadband, polycrystalline silver halide fibre bundle for confocal laser scanning microscopy in the near-mid infrared spectra

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Polycrystalline silver halide fibre bundles have been found to possess high transparency in the near to mid infrared (MIR) spectra and, as such, can expand the capability of conventional silica fibre based confocal laser scanning microscopy in the visible spectra to near and mid infrared microscopy within the same field of view. Such an extended capability can be enhance real time, large area imaging needs in burgeoning additive manufacturing industry, biological imaging especially for histopathology and cytology. These fibres can be also used in endoscope-based imaging. Making these fibres is difficult and requires high purity raw materials, specialized techniques and robust process control.

Maintaining the orientation of polarization of IR along the fibre is important for many applications, including confocal laser scanning microscopy (CLSM), where optical fibre bundles can be used as delivery channels. We have recently reported that $AgCl_{0.25}Br_{0.75}$ fibres can transmit IR but between 1 to 9 μm wavelength the fibres affect the polarization of the transmitted IR [1]. Here we use multimodal characterization underpinned by Multiphysics modelling the impact of materials and processing on the orientation of polarization of IR as it passes through such silver halide polycrystalline fibres.

Single crystals of silver halide solid solutions are isotropic. They have cubic NaCl lattice structure and have the same properties along all the axes. Depending on the shape and spatial orientation of the grains, polycrystalline silver halides may be anisotropic for IR radiation. The wavelengths propagated inside the optical fibres are in the range of 0.46-4.21 μm (for the wavelength range of 1-9 μm) [2]. Through scanning electron microscopy and scanning probe microscopy, we observe that a significant portion of these polycrystalline fibres is actually nanocrystalline. The structure is organized at two levels: microscopic grains with dimensions of 1-3 μm, and, nanocrystalline subgrains of 70-250 nm size. We conduct further scanning probe microscopy to understand the role of such nanocrystallinity and anisotropy in defining the local and global optical rotation.

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2. A. S. Korsakov, D. S. Vrublevsky, A. E. Lvov, L. V. Zhukova, *Optical Material* **64**, 40 (2017).