Light sciences, special glasses and optical fibres for infrared sources

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Abstract

Light sources in the mid-infrared (IR) between 2 and 20 μm, and even toward the far-infrared above 20μm, are of great interest for molecular sensing, medical, security and defense applications, as well as for free-space communications (1). Indeed, the mid-IR spectrum covers important atmospheric windows (3-5 μm and 8-12 μm) together with the spectral range of molecular signatures. The availability of broadband, coherent and high-brightness fibered sources has many advantages compared to thermal IR sources or quantum cascade lasers, and the generation of supercontinuum (SC) in engineered optical fibers pumped by femtosecond lasers is one way to reach this goal (2,3). In these waveguides indeed, an initial high peak power laser pulse, spectrally narrow, interacts with the nonlinear medium in such ways that its spectral width expands drastically during its propagation, to finally cover an ultra-broad spectral range. Over the last decade, considerable efforts have been made to push forward the results obtained with SC fibered sources in the NIR to the mid-IR, mainly with the aim of covering the largest possible spectral range (4-7). This implies to combine a material science trajectory related with glasses compositions, their infrared transparency and optical quality with the engineering of light matter interaction in dedicated waveguides, especially to enhance the optical nonlinear interaction between an initial propagating pulse and the optical fiber in which it is propagating. Developments are also focused on other aspects such as the realization of compact, fully-fibered, single-mode, coherent sources with high repetition rates and high power spectral density. Here, we propose to describe the state of the art in the field: through the different infrared glasses of interest, oxide, fluoride, chalcogenide and chalcohalide glasses, which infrared transparency is varying from 3μm to 35 μm and which optical nonlinearity is varying by orders of magnitude upon their chemical compositions; and through the engineering of optical fibers, their effective nonlinearity and their chromatic dispersion which are strongly dependent of their opto-geometric profiles, varying from standard step index to tapered profiles trough microstructured ones.

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