Spatial characterization of the response of a silica optical fiber to wideband ultrasound.

Abstract:
Optical fibers have long been recognized as a promising technology for remote sensing of ultrasound. Nonetheless, very little is known about the characteristics of their spatial response, which is significantly affected by the strong acoustic mismatches between the fiber and surrounding medium. In this Letter, a new method is demonstrated for wideband spatial acoustic characterization of optical fibers. The method is based on the excitation of a point-like acoustic source via the opto-acoustic effect, while a miniature fiber sensor is implemented by a 90°-phase-shifted fiber Bragg grating. Despite the relative complexity of acoustic wave propagation in the fiber, its spatial sensitivity in the high frequency band (6-30 MHz) exhibited an orderly pattern, which can be described by a simple model. This property reveals new possibilities for high-performance imaging using fiber-based ultrasound sensors, where knowledge of the sensor’s spatial sensitivity map is generally required.