1 Introduction

In optical sensing, the most recent and important enabling technologies are based on either the longitudinal or transverse structuring of fibers. Bragg gratings are a typical example of the longitudinal structuring of fibers, while microstructured fibers [e.g., photonic crystal fibers (PCFs)] are the promising enabling technology in terms of transverse structuring of fibers. Microstructured fibers provide materials with dispersion characteristics unattainable with conventional materials, as well as otherwise unfeasible physical characteristics that can be tailored to specific sensing applications.

Functional materials can be realized on the side- or end-face of fiber with many techniques, including sputtering, thermal evaporation, spin-coating, and so on. The combination of fiber optics with nanostructure technologies and functional materials offers great potential for the realization of novel sensor concepts. Miniature optical fiber sensors with functional coatings and thin films as sensitive elements could open new fields for optical fiber sensing applications. Functional coatings work as sensitive elements and transducers to get response and feedback from the environment, while optical fibers are employed here as carriers of sensing signals.

This Spotlight presents a general overview of the integration of microstructured fiber, fiber micromachining, and functional coatings for optical sensing engineering. The structure of this Spotlight is designed as follows: Section 1 gives a short introduction to these specific fiber sensor concepts and the outline of this Spotlight. Section 2 introduces the integration of optical fibers with functional coatings on the fiber tip for optical sensing applications, and two concrete examples including an optical fiber humidity sensor and sapphire fiber high-temperature sensor are given. A multilayer coating of $TiO_2/SiO_2/TiO_2$ can be deposited on the fiber tip for a relative-humidity (RH) sensing application, or one can deposit a multilayer of $ZrO_2/Al_2O_3/ZrO_2$ on a sapphire fiber tip for high-temperature sensing up to 1000°C. Section 3 introduces the integration of fiber micromachining with functional materials for optical sensing. Using femtosecond laser micromachining, different microstructures can be generated on fiber. When functional materials are deposited on such a microstructured fiber, an advanced performance can be expected, especially for fiber-optic sensing engineering. As an example, microstructured fiber coated with a TbDyFe magnetostrictive can greatly improve magnetic field sensing. Section 4 introduces the integration of a microstructured fiber with functional coatings for optical sensing applications. PCF is one of the very enabling technologies in terms of transverse structuring of fibers, and when it is integrated with functional coatings, new directions for sensing applications can be expected, including hydrogen sensing by combining hydrogen-sensitive materials (such as a Pt-doped WO_3 coating and a Pd-alloy thin film). An example of such an integration is demonstrated in this Spotlight. Section 5 is a short conclusion.