Nanooptics and nanophotonics

Correlation processing of speckle pattern in multimode polymer optical fiber for deformation monitoring in nanometer range

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The correlation methods of signal processing allow constructed fiber optic interferometer using only laser, multimode optical fiber and digital camera. Even the small deformation of multimode fiber cause the change of propagation conditions of guided modes and, consequently, the change of speckle structure formed at the exit end of fiber [1]. These changes can be detected by comparing the resulting speckle pattern with a reference pattern. A good comparison of the speckle patterns can be accomplished by spatially correlating them [2]. The intensity distributions of speckle patterns before and after deformation action on the fiber are compared by measuring the correlation coefficient for these signals.

We considered polymer optical fibers as they are more sensitive to deformation compared to silica fibers [3]. We assumed that the correlation coefficient of speckle patterns is determined by the fiber length change and it is independent of the other factors. The correlation method considered in the paper allows one to measure an axial elongation of the fiber within 0 to 6000 nm for typical multimode polymer optical fiber. The measuring range of such technique depends on properties of fiber and using wavelength. This algorithm of processing the speckle pattern in multimode fiber can be effectively used in interferometric fiber optic sensors for small deformation monitoring.

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2. *Pomarico A et al.,* Optical fiber strain gauge based on speckle correlation // Optics and Lasers Technology-1999.-**31**. P. 219-224.
3. *Silva-Lopez M., Fender A., MacPherson W.N., Barton J.S., Jones J.D.C., Zhao D. Dobb H., Webb D.J., Zhang L., Bennion I.* Strain and temperature sensitivity of a single-mode polymer optical fiber Optics Letters-2005.-30. **P**. 3129-3131.