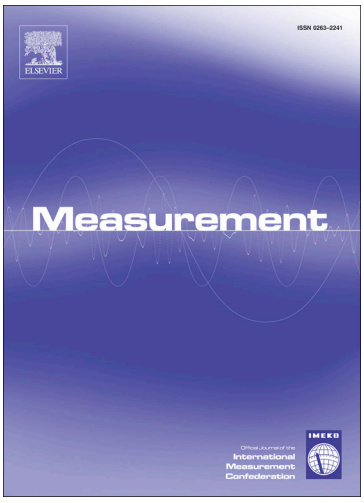

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Magneto-optical properties and measurement of the novel doping silica optical fibers

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Abstract

The magneto-optical properties for two kinds of novel doping silica optical fibers, Pb-doped optical fiber and Eu-doped optical fiber, are investigated. A measurement system is set up to analyze the Verdet constants of fiber samples, including Pb-doped optical fiber, Eu-doped optical fiber, single mode optical fiber (SMF) and Er-doped optical fiber (EDF). The system keeps extinction ratio (ER) and power of input linearly polarized light stable. For Pb-doped optical fiber and Eu-doped optical fiber, their Verdet constants are larger than that of SMF at different wavelengths (660, 808, 980, 1310, and 1550 nm), and their Verdet constants are increased with the decreasing of wavelength. Especially, the Verdet constant of Pb-doped optical fiber is 3.08 rad/T/m at 660 nm, which is 27.80% larger than that of SMF (2.41 rad/T/m) at corresponding wavelength. Verdet constant of Eu-doped optical fiber at 660 nm is -4.56 rad/T/m, which is 34.91% larger than that of EDF (-3.38 rad/T/m), and 89.21% larger than that of SMF at corresponding wavelength. Pb-doped silica optical fiber and Eu-doped silica optical fiber exhibit superior magneto-optical properties compared with SMF. Further, the magnetization of fibers are presented in the temperature range of 4-380 K. The magneto-optical property of Pb-doped optical fiber is more stable to temperature than that of EDF.

Keywords: Verdet constant; Silica optical fibers; Temperature characteristic; Current sensor.

1. Introduction

Recently, the use of current sensors based on the Faraday effect has been extended [1-5]. It's important to find doping magneto-optical materials with temperature independence, high Verdet constant and small size to improve stability, sensitivity and industrial integration of sensors. In a number of current sensors, rare-earth ions such as Tb^{3+}, Eu^{3+}, Ce^{3+} are attracted for their large Verdet constants which are caused by the $4f^n \rightarrow 4f^{n-1}5d$ transition of these ions [6-10]. However, their temperature dependent Verdet constants restrict the potential of increasing measurement accuracy. Some heave metal ions, such as Pb^{2+}, Bi^{3+} [11-15] which can improve both sensibility and stability of current sensors due to their high Verdet constant and small intrinsic temperature independence, have been widely studied. Although the Verdet constants of them are lower than that of paramagnetic materials, the stability of them are improved, which presents a remarkable advantage in the application of current sensors. What's more, many investigations focus on doping glass, garnet crystal and ceramics [9, 14, 16]. However, these materials are of higher cost, bigger size, and relatively poor transmission. Few researchers focus on doping optical fibers which offer