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Application of Side-polished Bragg Fiber Gratings to Magnetic Field Sensing Probe

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INTRODUCTION

In this paper, a new sensing probe based on side-polished fiber Bragg gratings (FBG) for magnetic field strength measurement of an Nd-Fe-B magnet was presented experimentally. Side-polished single-mode optical fiber (SMF-28) with Bragg gratings and iron coating was proposed as a magnetic field sensor probe. The optical fiber magnetic field sensing probe was based on the wavelength shift of the returned Bragg-signal measured from an optical spectrum analyzer (OSA). The intensity of the reflected optical signal is function of the Bragg grating wavelength, which is related to the applied strain on the FBG. Therefore, the magnetic strength of the magnet under different distancescan be derived from the intensity change measurement as a function of the wavelength of the reflected optical signal.

EXPERIMENTS

The fiber-optic magnetic field probe consists of aside-polished FBG (20 mm in length) and thin iron films with a thickness of 72 nm deposited on an interaction section. The thin iron film was prepared by the electron-beam evaporation technique. The intensity of reflected light from the Fe-coated section of FBG was measured by an optical spectrum analyzer (OSA). The interaction section of FBG, the effective refractive index of the propagation core mode is changed in response to an applied magnetic field. When the permanent magnet is gradually moved into the sensor probe, the center wavelength of the reflection spectrum was shifted relative into the shorter wavelength side relative to the one without the magnetic field (red line), as shown in Fig. 1.

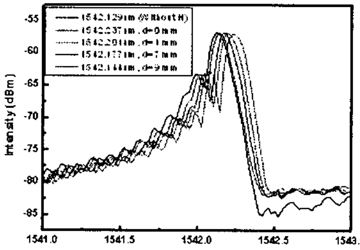

Fig. 1. Reflection spectra for different sensing distances.

RESULTS AND DISCUSSION

A newly designed optical fiber magnetic sensor probe composed of side-polished fiber Bragg grating and optical coating technique has been experimentally demonstrated. The results can be observed the Bragg wavelength shift to several 0.01 nm when an external magnetic field is applied. This magnetic-field probe could be used for monitoring magnetic field strength in harsh and high field environments.

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Analysis of Magnetic and Mechanical Properties of Amorphous Soft Magnetic Materials for Thin Film Devices

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This paper presents binary compounded amorphous thin films sputtered on the micromachined thin Si structure, and their magnetic and mechanical properties have been investigated with numerical and experimental methods for micro device application. For the numerical design and analysis of magneto-mechanical properties, finite element models are developed as magnetostrictive beam and plate elements. Many studies also show numerical models, especially finite element models, in the design and fabrication of magnetostrictive structures [1, 2], but their structures having large length to thickness ratio, which makes it very difficult to construct finite element mesh in the region of the thin film. So, intrinsic geometric feature of typical thin film is considered reasonably in modeling of the suggested magneostrictive elements. The binary compounded soft magnetic materials are consisted of Tb, Smand Fe to get positive and negative large magnetostriction. In the fabrication process, amorphous magnetostrictive films of the optimized binary compound $Tb_{0.35}Fe_{0.65}$ and $Sm_{0.4}Fe_{0.6}$ are deposited with thicknesses of 0.5, 1, 1.5μm on the silicon membrane by DC magnetron sputtering using cast composite targets. The sputtered composition is examined using EDS and the deposited film thicknesses are measured by X-ray diffraction. To characterize the magnetic and mechanical properties of the film deposited structure, the magnetization is observed using VSM and the magnetostriction is determined by measuring the differences of the curvature of the branch using the optical method. The magnetostriction of magnetized thin film makes deflection of the structures. As results, the measured deflection of the structure is 120μm max under 0.5T, indicated the lower than 5% discrepancy with FE analysis result.

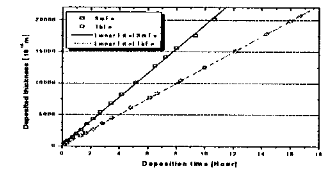

Fig. 1. Experimental sets up.

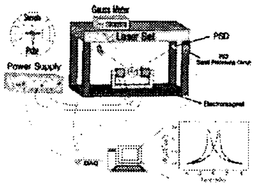

Fig. 2. Thickness measurement result from X-ray diffraction.

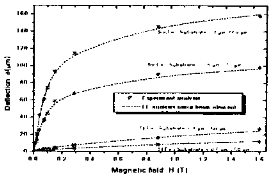

Fig. 3. Magnetostriction at each deposition rate.

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