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A setup for the measurement of the GMI response of amorphous wires under tensile stress

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This paper presents the design and development of an experimental setup that allows measurement of the Giant Magneto-Impedance (GMI) response of Co-rich amorphous micro-wires under tensile stress. A full description of the setup and the first performed measurements are given.

Keywords: Giant Magneto-Impedance (GMI), tensile stress, measurement setup

1. Introduction

Giant Magneto-Impedance (GMI) is a significant change of the AC impedance of some soft magnetic materials (amorphous wires...) when they are supplied by a high frequency current and submitted to an external magnetic field. This effect is used to develop magnetic sensors based on the impedance measurement of the sensitive element. Mechanical stress like tensile, if applied to the sensitive element, considerably modifies its GMI response [1]. This is an undesirable effect for a field sensor. Nevertheless, it seems relevant to make good use of this effect and to evaluate its potential to develop a new category of strains sensors or strain gauges [2]. The well understanding of the involved mechanisms and the measurement of these effects is an issue of great importance. This paper presents the design and development of a setup that allows measurement of the GMI response under tensile stress.

2. Measurement Setup

The developed setup is shown in Figure 1. It allows measuring the impedance of a GMI wire, under tensile stress, as a function of the magnetic field. From electrical point of view, a signal generator and a voltage to-current, (resistor \( R_s \)) supply the high frequency current \( i_{ac} \) to the wire. The voltage \( v_{ac} \) across the wire is amplitude-modulated by the external field \( H \) produced by Helmholtz coils. This voltage is demodulated using a home-made demodulator. The output of this demodulator, which is proportional to the modulus of the impedance \( |Z| \), is digitized by a data acquisition board for processing and visualization purposes on a PC. A straightforward calibration allows obtaining the impedance from the acquired voltage. The applied magnetic field can be automatically modified by controlling the DC power supply of the Helmholtz coils. The impedance curve could be displayed on a Graphical User Interface (GUI).

The mechanical arrangement allows applying a tensile stress on the wire in vertical position. The extremities of this wire were soldered to supports for mechanical fastening. The free extremity is also fastened to a holder (“basket”). The application of a tensile stress is ensured by placing a calibrated mass in this holder.

Figure 1: Schematic of the experimental setup.

3. Results

First results were obtained using an amorphous wire (CoFeSiB) with a 100 µm and 80 mm long (Figure 2).

These curves show a dependence of the GMI response on the applied tensile stress. The effect is particularly obvious around the field of the maximum impedance (inset of Figure 2). This field is directly related to the anisotropy field of the magnetic material. Further improvements of the setup should include arrangements for the measurement under torsion and bending stresses of the wire.

References