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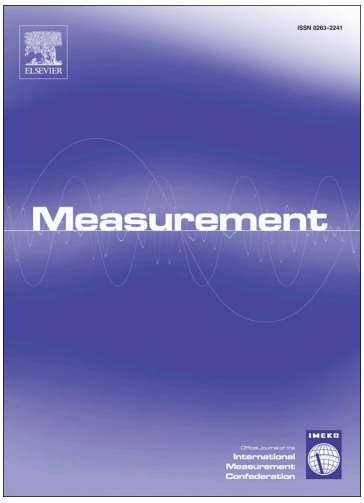

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PII: S0263-2241(18)30460-3
DOI: https://doi.org/10.1016/j.measurement.2018.05.070
Reference: MEASUR 5571

To appear in: *Measurement*

Received Date: 2 August 2017
Revised Date: 16 February 2018
Accepted Date: 18 May 2018

Please cite this article as: J.M. González, A. García-Arribas, S.V. Shcherbinin, V.N. Lepalovskij, J.M. Collantes, G.V. Kurlyandskaya, Broadband ferromagnetic resonance measurements in thin-film structures for magnetoimpedance sensors, *Measurement* (2018), doi: https://doi.org/10.1016/j.measurement.2018.05.070

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Broadband ferromagnetic resonance measurements in thin-film structures for magnetoimpedance sensors

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Abstract
Thin magnetic films and multilayer structures are commonly used for the development of micromagnetic sensors, some of them operating at high frequencies, as it is the case of magnetoimpedance sensors. At the same time, high frequency characterization techniques as ferromagnetic resonance are extremely useful to investigate material properties. In this work, we analyze the microwave resonant absorption of magnetron sputtered Permalloy-based magnetic films suitable for magnetoimpedance sensor applications. The dispersion of values of the resonant frequencies obtained in broadband ferromagnetic resonance measurements is used to assess the quality and the repeatability of the samples. The thin-film structures under test are inserted in the measuring circuit, constituting itself a part of the microwave transmission line, *i.e.* they are characterized in a realistic magnetoimpedance configuration, in which the alternating current flows through the sample. The ferromagnetic resonance frequency as a function of the applied field is determined from the measurement of the transmission coefficient in a network analyzer. We also present the data reduction procedure, adapted to our particular measurement test-fixture, that allows determining the ferromagnetic resonance spectra accurately. The analysis of the resonance is performed among samples identically prepared, either in the same production batch or in different batches. The dispersion observed in the results is used to estimate the fluctuations that can be expected in this kind of measurements and the amount of repeatability of sample preparation. The investigation indicates that variations of the order of 10 % can be expected in measurements that are usually considered to provide the same result.

Highlights

* Microwave absorption in magnetic thin films designed for applications.
* Broadband ferromagnetic resonance set-up using magnetoimpedance multilayers.
* Analysis among multilayered samples prepared in different production batches.

Keywords
Microwave absorption; Broadband ferromagentic resonance measurements; Magnetic permeability, Thin films; Magnetoimpedance; Quality assessment.

1. Introduction

The study of the high-frequency behavior of thin films and magnetic multilayers generates great interest in both the scientific and technological communities. From a fundamental point of view, the understanding of the magnetization dynamics in ferromagnetic materials is related to basic material properties and phenomena [1,2]. From the perspective of applications, new electronic products, such as inductors [3], magnetic field sensors [4-6] or microwave absorbers [7,8] require massive production of thin films with enhanced, well-defined and reproducible properties. In particular, many magnetic sensors incorporate magnetically soft sensitive layer hundreds of nanometers thick [9]. For magnetoimpedance (MI) devices, the effective thickness should be of the order of 1 μm [10]. This is especially important because, typically, thin films are magnetically soft only for thicknesses up to a few tens of nanometers [11-13]. A considerable effort has been made to develop magnetic thin films with suitable properties for sensor applications, in particular in the high frequency range [10,14,15]. Special emphasis is made on thin-films sensitive elements based on Permalloy ($Fe_{20}Ni_{80}$ alloy, Py), which display very low coercivity, high magnetic permeability and saturation magnetization [6,14,16,17].

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