

## Printed magnetic needle probe sensor (N5-13)

**H.S. Nguedjang Kouakeuo Hilary Sorelle<sup>1,2,3</sup>, Y.A. Tene Deffo<sup>1,2</sup>, B. Ducharne<sup>1</sup>, L. Morel<sup>3</sup>, M.A. Raulet<sup>3</sup>, P. Tsafack<sup>1</sup>, J.M. Garcia-Bravo<sup>4</sup>, B. Newell<sup>4</sup>.**

<sup>1</sup>Faculty of Engineering and Technology, University of Buea, Buea, Cameroon.

<sup>2</sup>Laboratoire de Génie Electrique et Ferroélectricité – INSA de Lyon, Villeurbanne, France.

<sup>3</sup>Laboratoire Ampère, Université de Lyon, 69621 Villeurbanne, France.

<sup>4</sup>School of engineering Technology, Purdue University, West Lafayette, IN 47907, USA.

The magnetic needle probes (MNP) is a sensor used to locally characterize the magnetic state of a ferromagnetic component. This method has a rich conceptual history, but it has never been used in the industrial field<sup>1</sup>. There are mainly two reasons for this: instrumentation limitations and inappropriate sizes of sensors' geometries. The first limitation has been overcome in the last 20 years due to large improvements in both the analog and digital electronic fields<sup>2</sup>. In this study, the second limitation, size/geometry is addressed by printing the magnetic needle probe using conductive ink directly on the ferromagnetic specimen to be controlled. The resulting sensor exhibits a drastic volume reduction. Such improvements allow measurement of the magnetic state of a previously inaccessible magnetic lamination through a magnetic laminated core. This opens up the possibility of measuring in situ magnetic behavior and monitoring many electromagnetic devices such as electric transformers, AC/DC electric motors, or even real-time electromagnetic non-destructive testing of ferromagnetic steel components<sup>3</sup>. Over the past few years, simulation approaches including space discretization methods: finite elements, finite differences, and boundary elements have been proposed to describe the internal behavior of magnetic lamination stacks but experimental results validating these simulations could not be realized due to the aforementioned limitations<sup>4-7</sup>. The printed magnetic needle probe method (PMNP) described in this paper can be used to collect such local information and to validate homogenization methods. Experimental validations are proposed by comparing the sum of the laminations magnetic induction, they are individually measured with the PMNP method to calculate the average induction obtained from a surrounding coil.

### References:

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