EXEMPLARY MAGNETIC PROPERTIES OF BILAYERED AMORPHOUS ALLOY CORE

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1. Introduction

Unique magnetic properties of amorphous alloys [1] make them the material of choice for the most demanding application. Some of the nanocrystalline or properly annealed amorphous alloys present ultra-high relative magnetic permeability [2] or low coercivity and highly linear B(H) characteristic [3]. Their utilization in magnetoelastic force sensors have been previously reported [4,5]. The current state of manufacturing technology [6,7] allows for moulding wires, ribbons and small bars of amorphous alloys.

This paper presents magnetic properties of the magnetic core composed of two amorphous alloys ($Fe_{67}Co_{18}Si_1B_{14}$ and $Co_{66}Fe_4Ni_1Si_{15}B_{14}$). Tested ring was ring-shaped and amorphous alloys ribbons were wound in bilayer pattern. There are not many reports [8] of similar measurements, despite relative simple construction of the core and potentially extremely interesting properties of such core.

2. Measurement stand

B(H) characteristics were made on a specially developed test stand for hysteresis loop – hysteresisgraph [9]. As presented in Figure 1, whole test stand is based on a data acquisition card, controlled from PC by dedicated software developed in NI LabView environment. Software provides real-time control for the setup's devices as well as measurement data processing.

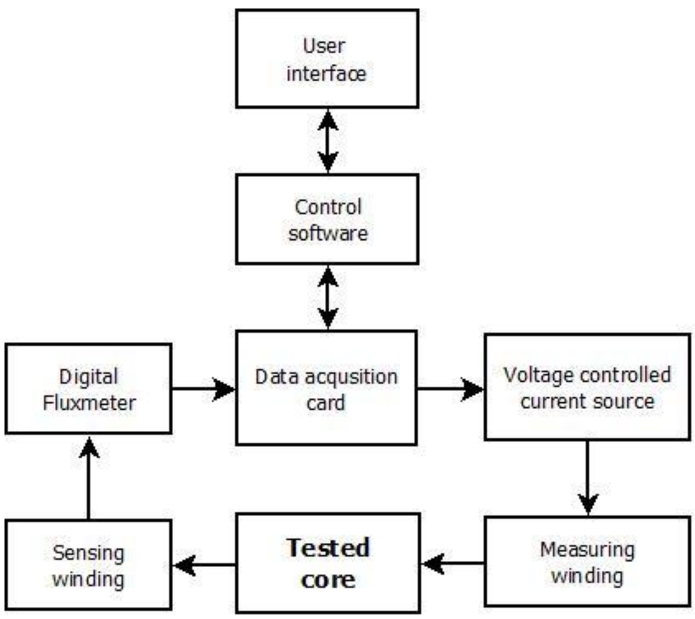

Fig. 1 Schematic block diagram of the utilized test stand – hysteresisgraph

Voltage signal generated by data acquisition card is controlling the current output from the Kepco BOP 36 voltage-current converter, which powers the magnetic winding of the tested core. Changes of the flux density B in the tested sample are measured by the digitally controlled fluxmeter, connected to the samples measuring winding. Fluxmeter provides voltage output signal, which is measured by the data acquisition card and converted accordingly to the fluxmeter settings. As a measurements result, setup generally presents B(H) characteristics. Series of measurement may be conducted with the constant frequencies (with varying values of magnetizing field H amplitude) as well as with constant amplitude of magnetizing field with varying frequencies. Such measurement series allow for obtaining u(H) and u(f) magnetic permeability characteristics of the tested sample.

Tested core was ring-shaped bilayer composition of amorphous alloys ribbons - $Fe_{67}Co_{18}Si_1B_{14}$ and $Co_{66}Fe_4Ni_1Si_{15}B_{14}$which both have high magnetic permeability and low (but different for each material) coercivity. Cross section of the tested core is 15 mm^2 and length of magnetic part equals 84,7 mm. Core was winded with 4 magnetizing windings and 200 measuring windings.

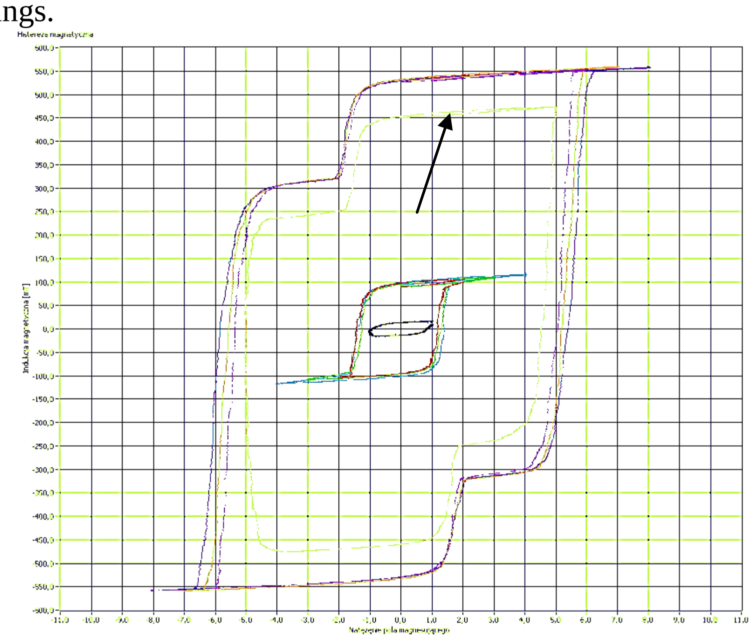

Fig. 2 B(H) loops measurement results, value of magnetizing field H 1÷10 A/m

3. Measurement results

Tested core was measured on a previously described setup in a series with constant frequency and varying amplitude of magnetizing field H. Obtained B(H) characteristics are presented in Fig.2. Arrow presents transition characteristics from single-phase hysteresis loops(under the arrow) to the double-phase constricted hysteresis loops. Characteristics for higher magnetizing amplitude presents that the coercive force of the second phase is reached.

Obtained μ(H) characteristics presented in Fig. 3 one can clearly see the maximal permeability for both alloys consisted in the core as well as (signalized with arrow) change of characteristic monotonicity.

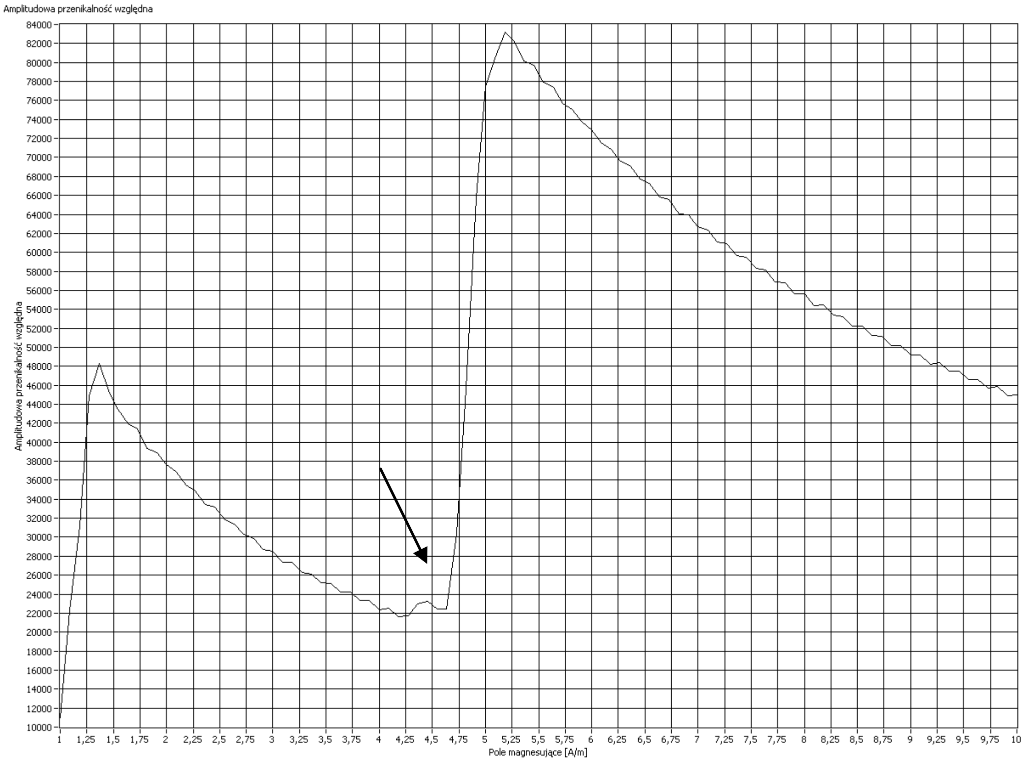

Fig. 3 μ(H) characteristics, value of magnetizing field H 1÷10 A/m

4. Conclusion

The obtained B(H) and μ(H) characteristics of the tested bilayer core exhibit high nonlinearity, more complex than in the typical ferromagnetic systems. Most interesting is the transition between single-phase and double-phase behavior, which can be potentially utilized in signal amplitude sensitive devices. Also usage of different alloys in bilayer cores may be an interesting method of obtaining desired B(H) and μ(H) characteristics for different applications.

Acknowledgement

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