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FIRST STEPS WITH DIGITAL AC MAGNETOMETER

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The setup of a computer driven digital AC magnetometer and their first tests are described. The magnetometer abilities are illustrated by measurements on closed and opened samples. The study of frequency influence is compared with DC measurement using vibrating sample magnetometer. Though the results are satisfactory also without special magnetizing and pick-up coils, their construction is essential for the AC magnetometer enhancement and finalization.

Keywords: magnetic measurements, AC properties, digital magnetometer

1 INTRODUCTION

Modern magnetic materials are in the focus of many scientific studies. The magnetic laboratory of our institute is equipped with a several precise devices for measurement of DC (quasistatic) basic magnetic characteristics, including vibrating sample magnetometer (VSM). However, there is still no possibility of AC measurements. Thus, last year we decided to complete our laboratory with an AC magnetometer giving more information about the magnetization process dynamics.

2 DESIGN OF MAGNETOMETER

The digital AC magnetometer, as originally designed by the colleagues from the CTU in Prague [1], is based on three PC plug-in cards. The crucial part of it is the 12 bit function generator (made by Datel) to drive the magnetization, completed with a pair of interconnected precise 14 bit AD converters (made by Janascard) for data acquisition. To feed the magnetization coils a 400 W audio amplifier is used. Its output impedance is 5 Ω. As no special yoke fixture was available, for testing of hardware older types of set-ups were connected. The first one consists of a compact magnetizing solenoid with a pair of compensated pick-up coils, without an RCP sensing of field intensity. It can be used for strip shaped (opened) samples. The second one is designed for closed samples in the shape of wound toroidal cores clamped in a special fixture between two halves of a magnetizing coil. The separate detachable pick-up coil embraces the fixture with the core of tested material inside. As both these setups were not designed specially for AC measurement, the frequency as well as the magnetizing power of testing was limited.

3 RESULTS OF TESTS

In the form of both opened and closed sample a Fe-B based amorphous alloy was measured, additionally a stripe of transformer steel was tested. The first two figures illustrate the results gained on the opened samples (Figs. 1, 2). The loops are not very noisy although no data accumulation was used and only a single cycle was plotted in both cases. Unfortunately, the impedance of both of the magnetizing coils was not close enough to the ideal value; too high for the opened magnetizing coil and too low for the toroidal winding. Thus, the full nominal output power of the amplifier could not be utilized yet.

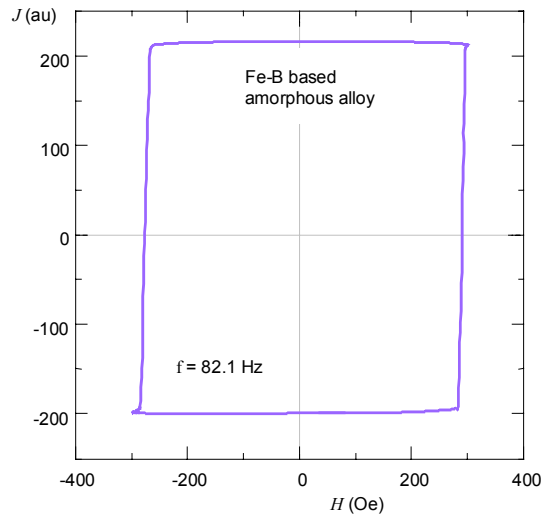

Fig. 1. Stripe of amorphous alloy measured in solenoid

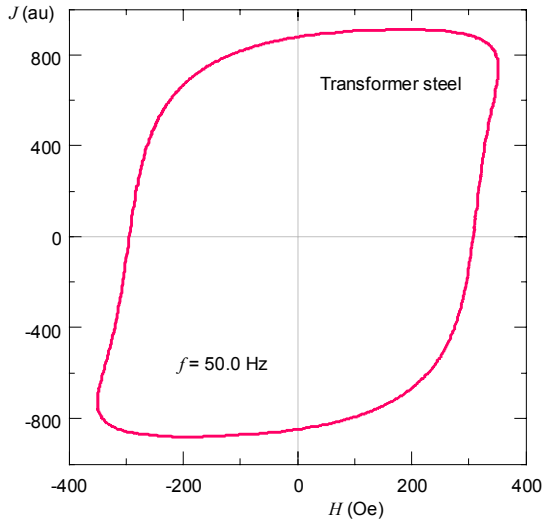

Fig. 2. Stripe of transformer steel measured in solenoid

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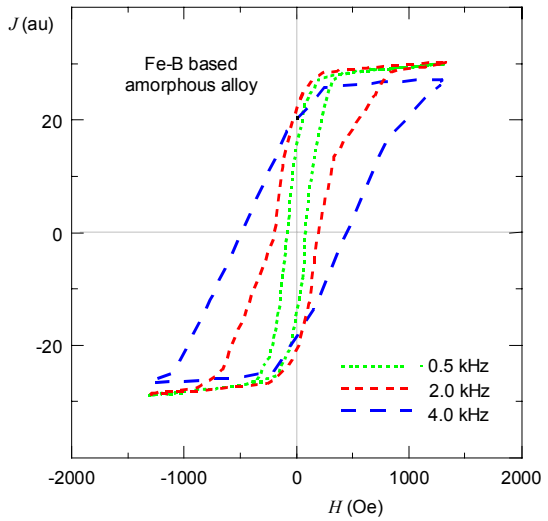

Fig. 3. Frequency dependence on toroidal amorphous sample

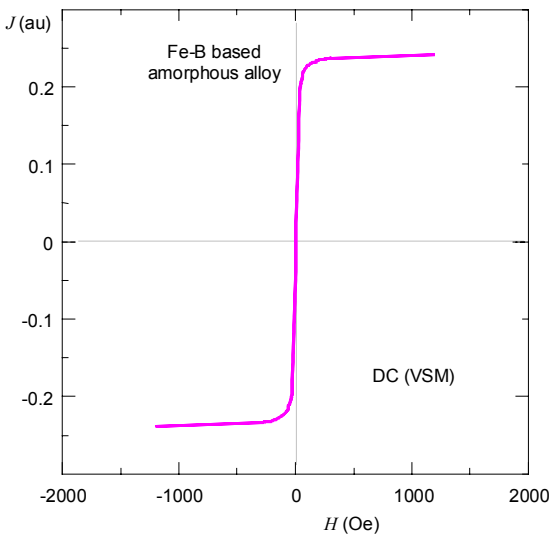

Fig. 4. DC measurement on amorphous sample, for comparison

Substantially higher field was achieved for the wound toroidal core. However, higher amount of material of a special shape was tested. To avoid the limitation of the amplifier output due to the low resistance of the clamped magnetizing coil a small value series resistor was added temporary. In the next figure, the frequency dependence of the magnetizing process is presented as measured on the closed amorphous sample (Fig. 3). The result is compared with the DC using the VSM (Fig. 4).

4 CONCLUSION

In spite of all problems, the results are quite satisfactory, especially for the amorphous alloy, where signs of saturation could be seen also in the weak field on the opened sample. It is obvious from the preliminary results that the new equipment comes up to expectations. However, to the maximum enhancement of the magnetometer, the construction of special magnetizing and pick-up coils, suitable to the rest of the hardware, will be necessary.

Acknowledgement

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