Design, Fabrication and Implementation of an Inexpensive Torque According To the Magnetic Anisotropy and Various Magnetic Materials

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Abstract:
The current research explores the design, Fabrication, and implementation of an inexpensive torque according to the magnetic anisotropy and various magnetic materials. It was observed that during the study that the competition between the magnetic field and anisotropy torque is shown at various levels of the strengths. This apparatus is made out of the surplus parts and items readily available in most Department of Physics in Pakistan .The system consists of rotatable electromagnetic assembly, sample suspension system and electromagnetic counter torque system. his apparatus has been calibrated and tested for some standard materials such as soft iron co-vd-alloy system. Torque L (O_H) obtained for different field strengths were discussed in the context of competing for torques, i.e., because of applied magnetic field and anisotropy of the system
Keywords: Design, Fabrication, and working of torque magnetometer

2.1 Introduction

In the chapter, we describe the design of the torque magnetometer. We have Constructed, as well as the detail of the equipment used in its construction. This chapter Also includes the working mechanism of each part and its role in the determination of the Torque. Finally, the test calibration of this torque meter will also be discussed.

2.2 Schematic of the instrument the torque magnetometer is constructed from surplus apparatus parts and items Readily available in most physics departments in the country. The system is based on a design By Penoyer [3]. However suitable modification have been made according to our needs and available resources .the system is consists of a rotatable magnet assembly a sample holder

Assembly and a counter torque system.

The schematic of the instrument is given in Fig 2-1.An electromagnet (E) can be rotated to Provide an applied field perpendicular to the vertical suspension axis at various angles in the My plane.The specimen holder (H) is supported by two stretched wires T1 and T2, the ends of which are supported by the top and bottom springs, S1 and S2. A sample is attached to the sample holder (H), which is located between the pole pieces of the orating electromagnet (E).This sample holder is also connected by a thin glass rod (R) to a coil (C) located above the magnet (E) and between the pole faces of a small stationary electromagnet (D). By means of a needle (N), attached to the coil, the torque exerted by the sample is balanced by sending the feedback current through the coil ©, placed in a field of the permanent magnet (D), The man components and the basic functioning of each component is as follows:

2.2.1 Electromagnet

The electromagnet used is the model CENCO .NOS 079637-007. This model is a precision electromagnet that meets field strength and homogeneity specification of the electromagnet. It produces a field strength of 11,000 gausses across an inch gap at a current level that permits continuous operation with water-cooling.

Its mass is about 150 kg. The two coils of the electromagnet are mounted in a square-shaped yoke Fig 2-11. This magnet gives high uniformity to the field even at relatively large radial distances from the center of the pole face. The gap between the pole pieces is adjustable and can be changed as needed. The pole pieces and pole faces are hard chrome plated of protection against erosion.

A gap of about 5.74 cm is set between the pole faces, which then give a field of 700 one per ampere of current. The magnet is mounted on a rotating assembly especially

The idea of using torque magnetometer to measure the anisotropies of magnetic materials is based on the rotation of total moment with reference to the sample's initial direction in the presence of a uniform magnetic field. Now there were two options.

One can either rotate the magnet or rotate the sample. We performed tests to determine if sample rotation was feasible and found that the rotation of the sample produced vibration, which was a major problem. Moreover, we could not construct the counter torque system in the case. Hence, we constructed the rotating assembly to be able to rotate the electromagnet. The main problem in this construction was the 150 kg (approximately) weight of electromagnet. We have to choose a design, which enables rotation of this heavy load. Main parts of the assembly are shown in figure 2-2. The assembly of the rotating disc is dividing into two parts:

Holding plate

The plate, which carries the entire assembly of sliding rod (vertical support for Countercurrent system (sec.2.2.9), measuring scale plate, stationary magnet, mounted Coil and the protective covering, is named as holding plate.it is a simple white Colored hard plastic sheet with the dimensions of 39*31.5cm2(fig.2-10). This sheet is placed on the iron strips fixed at the upper surface of torque Magnetometer holding frame. several hole and slots were drilled through it in order to Fix different assemblies. there are two main holes of size 1cm and 1.5*0.3cm2 respectively .first one is for passing the glass rod (sec.2.2.6),while the other one is For passing the sliding rod.two of them are to fix the sliding rod .around the main Hole made for the purpose of passing glass rod the two more holes are drilled to fix The protective covering of glass tube .we have also made arrangements for the two connections ,coming from the coil,by attaching two knobs over the surface of plate Moreover a potentiometer of 5k is fixed on the plate

Moving Coil

The most crucial element of the torque meter was the moving coil assembly after a large Number of trails on coils obtained from various models of standard moving coil Galvanometers we have selected one which was more suitable for us.this one was the part

Of the standard avo meter (Simpson 269,series3) The selection of coil was made on the basis of the following considerations Coil dimension (to enable to fit in according with the permanent magnet gap); Coil resistance and its wire gauge (to be able to carry the required current for balancing); This balancing current provide to the coil would generate a magnetic moment m according to the expression.

M= (2.1)

Where A is an area of the coil, is current passing through it, n is the number of turns in it, and so is the permeability constant.

Our selected D coil has dimensions of 2.8*2.35cm2 and resistance 3.7k. we glued connect both at upper and lower side of the coil with the originally attached thin small pins (fig. 2.6). The upper connectors connect the upper torsion wire with the upper torsion wire with the coil, while the lower connectors are fitted with the rigid glass rod. A thin needle of length 13cm is glued with the coil parallel to the upper surface such that needle is pointed exactly in the center of the coil. This arrangement ensures us the deflection of the coil as the moment produced by passing current in the coil interacts with the fringing field of the permanent stationary magnet as shown in figure 2-4.

Torque, it can be transferred to the moving coil and vice versa. After several trials on plastic rods and glass tube finally, we selected a thin glass rod of 2mm.o.d which was cut to 27cms. Of length. One end of the rod is attached to the connector,located on the lower side of the moving coil fig2-6. A plastic tube of 1.5 cm length is used to attach the connector and the glass rod. The other end of the glass inserts in the hole. Made on the upper side of the sample holder. here we used a plastic knob to fit the rod tightly. A connection coming from the lower connector of the coil is wounded around the glass rod and soldered at the connector placed at the bottom of the sample holder. In this way, the glass rod provided a path to lower current lead without any disturbance in the moment of the coil

2.2.8 Sample holder

It is made of Teflon is study, machinable and nonmagnetic. As shown in the figure 2-5 the simple holder is cylindrical with an external diameter of 13mm and length of 16mm.this cylinder consists of two pieces which can interlock with each other upper piece of the length 11.3 has the circular groove of o.d=11mm and depth=3.3mm at its lower side. While the lower prices this grove with an inner diameter of 11cm and depth of 0.1cm at its upper end. Therefore the sample with maximum diameter of 8mm and thickness of thereof 3mm can be easily placed between the two pieces .by aust of their diameters,

3.3 CENTERING OF THE SAMPLE

To locate the saddle point, i.e., o (0, 0, 0) position of the sample wart, the x and y pick-up coils we used a standard sample of Ni (2.460 emu) provided the manufacturer. The sample was of disc shape having the diameter of 5mm. we glued sample to sample holder and inserted the pick-up coil holding assembly from the lower end of the sample rod, adjusted it in a way that sample become roughly at the center of the coil assembly. The magnitude of the eminence of the sample was known before. By using the X, Y and Z position adjustments at the mechanical head of VSM, we located the saddle point confirmed by the reading on LIA, s.

Although we have levered the mechanical head assembly carefully and found the saddle point, it is still difficult that the rotational axis of the head is exactly normal to the XY plane of the X and Y coil sets. The shown figure 3-6 is the just ideal case. As due to the long length of the sample rod, any position of the head would result in not only the same degree of rotation of the sample around its center, but also a small translation away from the point O. hence, if the total rotation from one direction to the either is larger than about 45o, the saddle-point position will be slightly off. For this reason, unless the angular dispersion of the sample is small, the errors in the vector-VSM measurements are bound to be considerable [3]

3.4 CALIBRATION OF THE SYSTEM

Discussion

The work performed in this project has consisted of two parts. In the first part of the work, two measuring system was constructed for determinations of the anisotropic. Magnetic response of materials. The first system was a torque magnetometer, which stands by itself independent of any other supporting instruments.

The instrument was constructed, tested refined to some extent and then calibration tests were performed the general working of the magnetometer was found to be satisfactory within limits imposed by the component parts. Basically, the general limitation of our torque meter was that it was confined to systems with small remnant moments. For higher values of the same, it becomes very difficult to produce the nulling torque via the balancing coil. This also confined us to wrong at low values of the fields. This however is not a serious problem for future work on this instrument and can be overcome by choice of a suitably strong permanent magnet with a sufficient gap (25mm) to enable the balancing coil to be located within the gap within these limitations the anisotropy behavior of several sample (Co-vd-of the vocally was studied to different extents .The anisotropy constant was determined for Co-vd sample, and the values were found to be quite reasonable .The overall variation of the magnetization angle was also obtained for different fields. The basic

The picture to emerge as that for fields well below the coercive field the moments tends to stay close to the initial direction particularly at small angles while as the field and angle are increased the increasing torque pull the moments away from the anisotropy direction. Thus the torque magnetometer provides us with a powerful instrument for determining the anisotropic magnetic responses well as detraining the crucial question of how the magnetic moments turns at different combinations of coercively, romance and applied fields. This system can be used in a more powerful way, provide well characterized and preferable single crystal samples are available, e.g., to determine the anisotropy axes or the anisotropy constants.

The second part of the work involves the construction of transverse pick-up coil system, which was added to the VSM and enables the measurement of the transverse component of the moment. This enables us to the measurement of the transverse component of the moments. This enabled us to measure the oration of the moment, and torques (indirectly as functions of the field and sample characteristics. This system was more versatile in the given conditions due to the very sensitivity of the VSM and the indirect torque terminations as opposed to the direct measurement in the caps of the Torque Magnetometer.

Conclusions

The basic characteristics which w found in various samples using this method for the vocally and Fe-Co-Cr alloy confirmed some of the observation made using the torque magnetometer while other new features were also added. Essentially we observe the general trend of moments orating rigidly with the sample at low fields tending to lag behind the oration at high field. We also find the shift of torque maxima to lower angle with increasing fields. However, we also observe some anomalous behavior .The vocally showed a maximum magnitude of the torque at 60, i.e., at the higher field, the peak valued of the torque is smaller. This is explainable in the sense that at this field the torque is large introducing these screws we can not only align the position of the coil with respect to a stationary magnet placed on the plate but can also adjust the position of the sample (which is attracted to the coil assembly) between the electromagnet.

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