Development and construction of a measurement system for recording magnetic hysteresis loops

Magnetic hysteresis describes the behaviour of a ferromagnetic material during magnetisation and demagnetisation by an external magnetic field. The hysteresis loop can be used to determine characteristic material parameters, such as remanence, coercive field strength and saturation magnetisation.
The aim of this student project is to develop and construct a measurement system for recording hysteresis loops using two Helmholtz coils. Through precise control, the aim is to generate a magnetic field that is as homogeneous as possible and to vary its strength and direction in a controlled manner.
The magnetic response of the specimen is recorded by means of two pickup coils connected in series in opposite directions. This series differential circuit enables the directly coupled excitation signal to be largely compensated for, thereby improving the measurement of the specimen's magnetic contribution.
The first part of the assignment involves the design and construction of the measurement system. To this end, the Helmholtz coils must be designed with regard to coil geometry, number of turns and the required magnetic field strength. In addition, the pickup coils and a suitable sample holder are to be designed and positioned. Particular attention must be considered for field homogeneity and signal suppression via the differential circuit.
The second part of the assignment involves procuring the necessary materials and components, as well as the mechanical and electrical assembly of the measurement system. Furthermore, suitable components for the power supply, coil control and measurement data acquisition must be integrated. Control and evaluation software is to be developed to automatically carry out the magnetisation cycle, capture the measurement signals and plot the hysteresis loops.
Finally, the measurement system must be characterised and validated in terms of the generated magnetic field strength, signal quality and reproducibility. To this end, hysteresis loops of suitable reference materials are to be captured and the magnetic parameters determined from these are to be compared, as far as possible, with literature or reference values.
The design, the experimental setup and the results of the characterisation and validation must be documented in a final report and presented within the scope of a talk.

Prerequisites:

- An interest in materials science and magnetism
- (Basic) knowledge in the field of electrical engineering and sensor technology

Type of opportunity:

- **Practical placement and Bachelor's thesis (30 ECTS) at the WWHK**
- **Research and development module (30 or 30 ECTS) at the WWHK**
- **Master's thesis (30 ECTS) at the WWHK**

Duration and extent depend on the study regulations and the nature of the student's work

Start date: immediately

Contact: Viktor Lyamkin