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Contactless magnetoresistance and magnetic hysteresis sensor for measuring minerals in industrial applications

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In many minerals, the magnetic permeability and/or the resistance depends on the applied magnetic field. These properties, magnetic hysteresis and magnetoresistance, could therefore be used as a way of identifying minerals to differentiate ore from waste in the mining industry. This application requires the properties to be measured without electrical contacts, operate at room temperature and in low magnetic fields. We have created a lab-based instrument that is capable of simultaneously measuring the magnetoresistance and magnetic hysteresis of granular materials at room temperature. This instrument is designed to be scaled up for use in a mining application. The instrument consists of a Helmholtz coil, a radiofrequency power supply, a simple well-characterised radiofrequency circuit and custom circuitry for analogue processing of the signal before it is digitized. In this setup, a periodic time varying magnetic field is applied to the circuit using the Helmholtz coil, thereby inducing a periodic resistance and permeability change in the material. The periodic changes in the impedance of the radiofrequency circuit at the resonant frequency that are induced by the oscillating magnetic field are measured. Using Fourier analysis, the coefficient of magnetoresistance and the parameters of a magnetic hysteresis model to be determined. The magnetoresistance of bismuth and simultaneous resistance and permeability changes in an iron ore sample were successfully measured with this setup.

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