

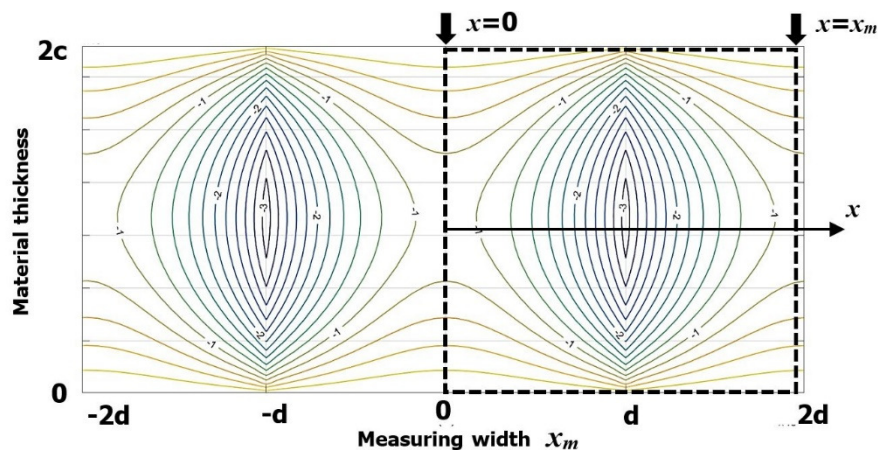
Electromagnetic modelling of the magnetic needle probe method from parallel domain structure by FD approximation (G2-10)

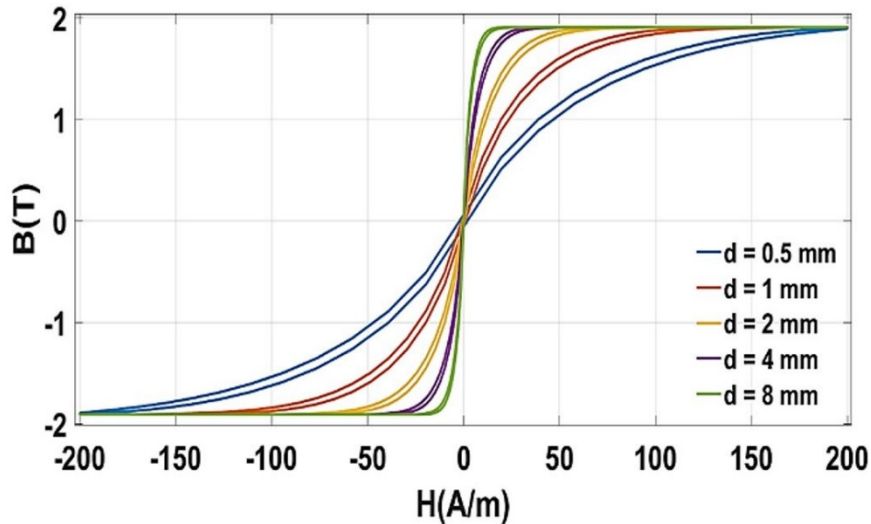
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Magnetic characterization is an undeniable scheme for the identification of magnetic and mechanical properties of materials^{1,2}. More pertinent is the unavoidable urge for localized magnetic monitoring schemes in line with the current growing industrial expectations^{3,4}. Herein, the adequacy and consistency of the magnetic needle probe (MNP) method over the conventional search coil method were concealed by the instrumentation prerequisite coupled to very weak levels of the sensor signals and the limited theoretical investigation on the method, generally considered quite blurry. The first hindrance taken care of by technological upgrades, studies on the basis of the electromagnetic theory from eddy-current distribution in magnetic materials has advanced the interpretation of the MNP method for local magnetic measurements^{5,6}. The objectives of this paper are twofold; it presents an electromagnetic modelling of the MNP method in a rectangular bar from a micro-magnetic perspective and exploits the model to derive the magnetic anhysteretic behaviour of the ferromagnetic materials. In the first objective, the advance theoretical background of the MNP method is modelled for anti-parallel domain structure using Finite Difference (FD) approach and compared to the analytical approach in^{5,6}. Then, the model is used to simulate the reversible stochastic motion of domain walls for a hysteresis free magnetic material. The dependence of the anhysteretic model on the domain width (d) and the ratio of domain width to the thickness (d/c) of a Fe-3%Si sheet tells of the sensitivity of the magnetic microstructure on the magnetic signature. Noticeable hysteresis losses were however observed at smaller domain width translating to a state of high magneto-crystallographic anisotropy where closure domain effects add the resultant magnetization in the magnetic material. A complete account of the domain constituency is envisaged for future studies.





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