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Transmission line analysis of meander type amorphous ribbon pattern

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It is well known that the impedance of a magnetic material may be changed by an external magnetic field as the magntoimpedance(MI) effect[1]. The various measurement techniques can be applicable to determine the MI in soft magnetic wires, ribbons, and films, such as LCR meter method, constant AC current method, network analyzer method, and so on. When the measurement is carried out in the frequency of over several hundred MHz, the stray electric/magnetic field effects should be considered with the equivalent circuit parameters (R, L, G, and C), which can be obtained by solving the magneto-dynamics and Maxwell equations. In addition to this, it should be pointed out that the characterization of a magnetic pattern determined by a lumped circuit model is not exact when the geometrical dimension is not sufficiently smaller than electromagnetic wavelength. In this study, the meaner type amorphous ribbon patterns, which are 10 mm long, 25 μm thick, 0.5 ~ 1 mm wide, and 4 turns, were composed as signal conductors of transmission lines mounted in the 50-ohm matched measurement system using a network analyzer. And, the impedances and its magnetic field dependencies of the patterns were determined as a function of frequency (0.3 MHz ~ 3 GHz). Figure 1(a), (b) and (c) show, as one of results, the measured impedance Z, resistance R, and reactance X spectra of the short-ended transmission line (STML) of the 700 μm-wide pattern, respectively. The Z of the STML has peak values at near the frequencies equivalent to 1/4, 3/4, 5/4 and 7/4 wavelength, The peak values and frequencies are shifted by the applied magnetic field which give rise to the change of impedance dispersion properties. As shown in these figures, the electrical characteristics of the pattern near the peak frequencies are more radically changed by an external magnetic field even if they are determined in the frequency range of a few GHz, in which the permeability of this material has extremely small amplitude. This inform us that the magnetic and/or MI properties can be determined more exactly by the transmission line model than a conventional lumped parameter model.

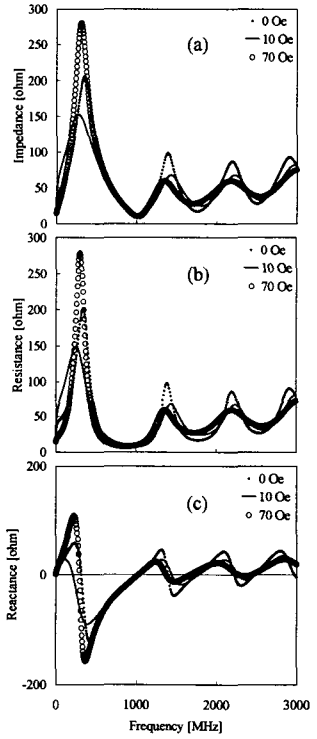

Fig.1. Z, R, and X spectra of the meander pattern.

References

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