EC01

On-Chip Transmission Line Study and Its Application to Integrated Electromagnetic Noise Suppressor

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Thin-film transmission lines with less-than-10 µm-wide narrow signal line were designed and obtained utilizing silicon chip fabrication service with 0.15-0.18 µm design rule. Typically the service offers 0.5-2 µm thick four or fime metal layers, which gives large design freedom to complete coplanar line, microstrip line, sheilded coplanar line, etc. These transmission lines can be usd for generating RF magnetic field to study the dynamics of nanoscale magnetic materials, spintronic structures and innovative new devices including electromagntic noise suppressor [1], [2]. On the other hand, there is a strict design restriction that the materials used in the test chip, their physical parameters and their thickness are all given and cannot be modified.

All the design restrication are adjusted to obtain a 2mm-long coplanar line with 8 µm-wide signal line. It exhibited a constant characteristic impedance up to 20 GHz. Basic properties of coplanar lines and microstrip lines with different design have been studied. Then a Fe/Fe_3O_4 composite material [3] was dropped onto the CPW and the S parameters were measured using on-wafer probes technique. The measured insertion loss was as small as 0.15 dB at 1 GHz and 4.8 dB at 20 GHz, demonstrating the usefulness for a noise suppressor.

The magnetic composite is also useful for electromagnetic shielding. The composite was dipped on to a packeage-open micro processer chip (HD64F3694FX, Renesas Technology, Co.) to the thickness of about 200 µm to be appleid to magnetic near field measuremnt, as shown in Fig. 1. The detected peaks were successfully attenuated by 3.0-6.7 dB in the frequency range of 40 MHz-2.0 GHz.

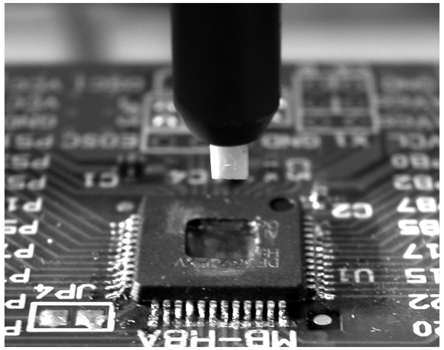
Fig. 1. Magnetic near field measurement.

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EC02

Development of Integrated Magnetic Thin Film Devices for RF Applications

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In recent years, various microwave applications of soft magnetic thin film such as integrated RF magnetic thin film inductor [1], [2] and integrated magnetic thin film transmission-line device [3], have been reported. The authors is currently developing the integrated magnetic devices into CSP (Chip Size Package) RF-ICs as shown in Fig. 1. The CSP is fabricated after semiconductor process, and the magnetic device process is compatible to the CSP except magnetic thin film deposition. Therefore an addition of magnetic thin film can be miniaturized the CSP RF-ICs. As one of the integrated magnetic devices for CSP RF-IC, the authors have developed a wideband CoFeB/ Polyimide thin film directional coupler for cellular phones [4]. The newly coupler consists of a pair of coductor lines (main and sub libe) with enhannced magnetic coupling through the lower CoFeB amorphous magnetic thin film, and Polyimide MIM (Metal/Insulator/Metal) capacitors located in four ports for electric field coupling between main and sub line. In the new coupler, magnetic field coupling and electric field coupling are nearly independent each other. The coupler operated under non resonance mode and exhibited an insertion loss of below 0.5dB, coupling factor of -24 to -14 dB and isolation of below -25 dB, which were satisfied in the wide frequency range of 0.6 to 2.4 GHz.

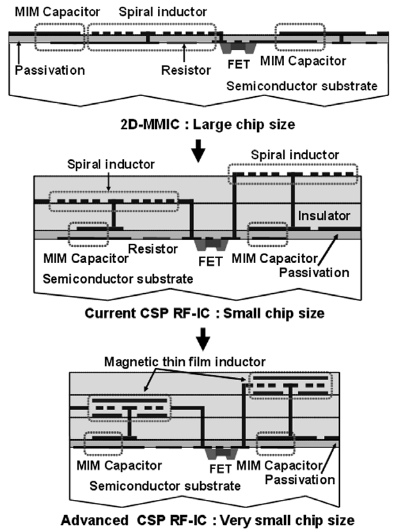

Fig. 1. From current CSP RF-IC to advanced one with integrated magnetic device.

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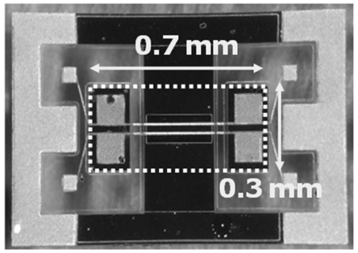

Fig. 2. CoFeB/Polyimide thin film directional coupler.