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A Novel GaAs Spiral Inductor for Reducing MMIC Chip Size.

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Abstract

In the recent progress of monolithic microwave integrated circuit (MMIC) technology, passive inductor and capacitor have become important components in MMICs [1]-[2]. Spiral inductors have widely used in various MMICs such as power amplifiers, low-noise amplifiers and phase shifters [1]. To reduce the MMIC chip size, the development of small passive components is required

In this paper, metal-insulator-metal (MIM) spiral inductor on semi-insulating GaAs substrate is proposed. We show the several characteristics of the MIM spiral inductor, and an application of the proposed inductor for reducing MMIC chip size.

Figure 1 shows the schematic of the MIM spiral inductor. The first electrode deposits the spiral on GaAs substrate. Passivation (SiN) is composed on the first electrode. The second electrode deposits on the passivation layer. In this structure, metal (first electrode) – insulator (SiN) –metal (second electrode) is composed. Figure 2 shows the cross-sectional view of the MIM spiral inductor. The first electrode is composed of aluminum with electrode width of 20 μm. The second electrode is composed of Ti/Pt/Au with electrode width of 18 μm. SiN layer is the thickness of 0.2 μm, and relative dielectric constant of 7.0. The thickness of GaAs substrate is 100 μm. Figure 3 shows the top view of the MIM spiral inductor. The line width, the line space and numbers of turn of this spiral inductor were determined by using a microwave simulator. An inductance of the spiral inductor is 3 nH. We fabricated the MIM and the conventional spiral inductors. We also measured S-parameters of each inductor using TRL (Transmission-Reflection-Line) calibration. Figure 4 and 5 show the impedance characteristics and insertion loss characteristics of the MIM spiral inductor. As shown in Fig. 5, it can be seen that the MIM spiral inductor slightly has large insertion loss compared with conventional spiral inductor. The first electrode is composed of aluminum. Because of the resistivity of aluminum is larger than Ti/Pt/Au, the insertion loss of the MIM spiral inductor is larger than conventional inductor. However, measured data of MIM and conventional spiral inductors which designed an inductance of 3 nH are in a good agreement shown in Fig. 4. Therefore, the MIM spiral inductor is exhibited the inductance of 3 nH. We show that one of the application for the MIM spiral inductor in Fig. 6. Figure 6 (a) and (b) show the gate circuits in MMIC amplifier. By using the MIM spiral inductor shown in Fig. 6 (a), the MMIC without DC block capacitor has been realized. Therefore, the MIM spiral inductor is effective for reducing MMIC chip size.

References

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[2] E.Pettenpaul, H.Kapusta, A.Weisgerber, H.Mampe, J.Luginsland, and I.Wolff, " CAD models of lumped elements on GaAs up to 18 GHz, " IEEE Trans. Microwave Theory Tech., vol. 36, no.2, pp.294-304, Feb. 1988.

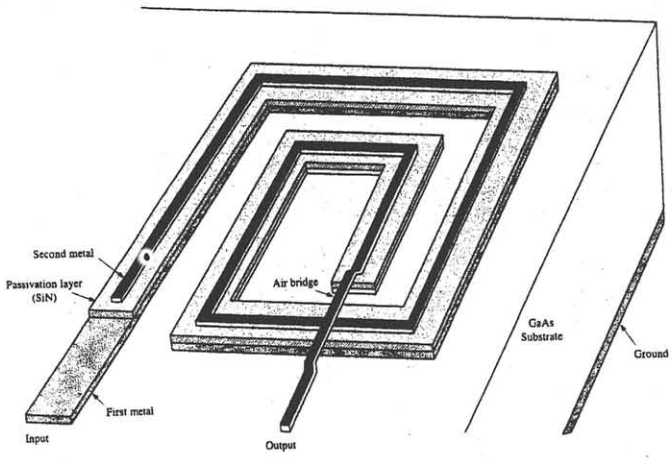

Fig. 1 Schematic of MIM spiral inductor.

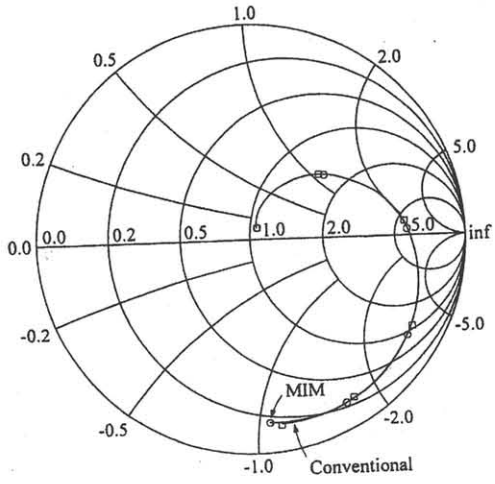

Fig. 4 Impedance characteristics of MIM spiral inductor.

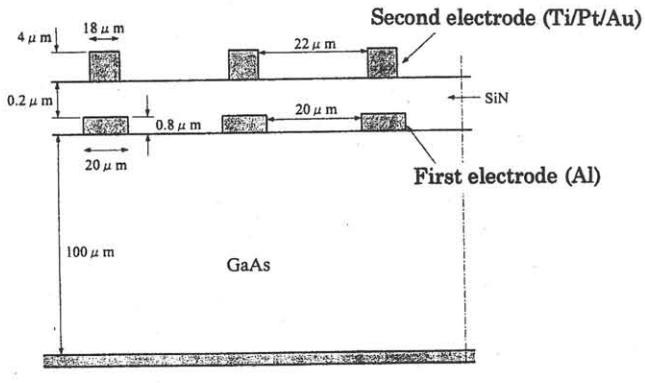

Fig. 2 Cross-sectional view of MIM spiral inductor.

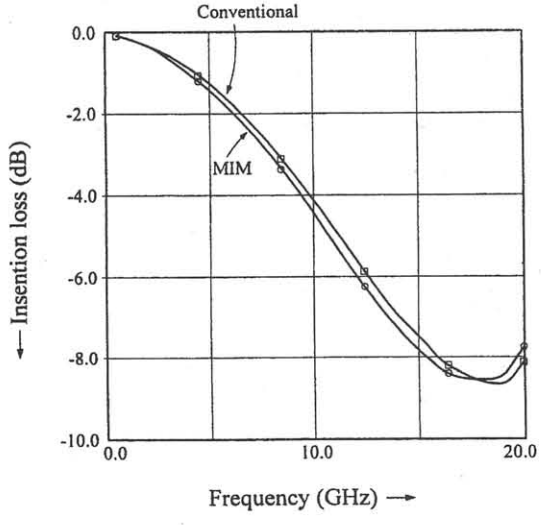

Fig. 5 Insertion loss characteristics of MIM spiral inductor.

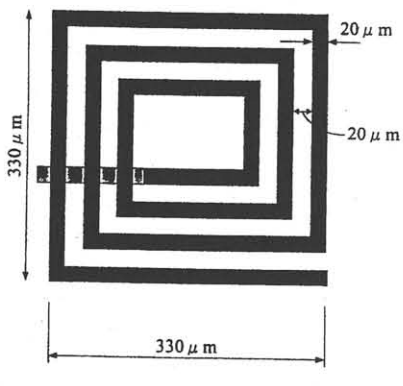

Fig. 3 Top view of MIM spiral inductor.

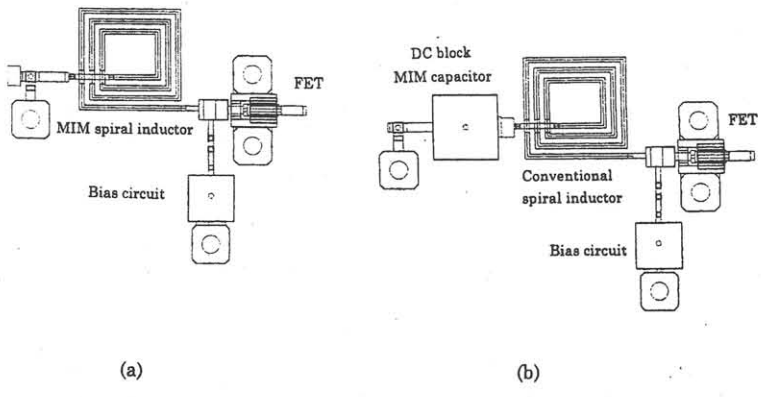

Fig. 6 Application of MIM spiral inductor, (a) gate circuit of MMIC amplifier with MIM spiral inductor, (b) gate circuit of MMIC amplifier with conventional spiral inductor