Design of a Highly Efficient Transition from Guided Mode of the Microstrip to the TM Mode of the Spoof Surface Plasmon Polariton

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This paper presents the design and characterization of a highly efficient transition between the guided modes of the microstrip and highly confined mode of the spoof surface plasmon polariton (SSPP). Conventional microstrip suffers from crosstalk and mutual coupling problem which are not desirable in the design of integrated circuit. This problem can be overcome by using spoof SPP based circuits. Natural surface plasmon polairtons are found at optical and near infrared frequencies at the interface of the metal-dielectric. These surface modes are highly confined and localized near the interface thus provide the way for developing highly miniaturized integrated circuits. However, such exotic properties are not found at lower frequencies i.e. THz and microwave. To achieve such properties at these frequencies an engineered structure was proposed which presents the SPP-like characteristics and supported at the interface of the metal and dielectric (S. A. Maier, Plasmonics: Fundamental and Application, Springer 2007). Since the characterization setup is available for TEM waves hence to characterize the spoof SPP based structures, a gradual transition needs to be developed. Here, a symmetrical stepped bow type spoof SPP unit cell is employed to design this transition. In previous works it is demonstrated that bow type unit cell has higher confinement ability as compared to the conventional H-shaped. Moreover, a stepped bow is used to generate sharp rejection at the stop-band. Fig. 1(a) and (b) shows the schematic and fabricated prototype of the proposed design of the transition structure. This transition consists of gradual conversion region and spoof SPP supported unit cell. This gradual conversion helps to convert the QTEM mode into the TM mode as the height of the grooves increases from $h_1=0.5$mm to $h_8=4$mm. The optimized parameters of the unit cell are as follows: $h=4$, $a=4$, $d=4$, $b=3$, $s=2$, $g=0.5$ (*all in mm*). The S-parameter response is shown in Fig. 1(c). Both the simulated and measured results shows excellent transmission efficiency with the bandwidth from *1*GHz-*5.5*GHz. Insertion loss is ~*0.3*dB and reflection loss are below *10*dB within the transition band. Fig. 2 depicts the near field distribution for the designed transition. It is observed that the field is highly confined near the teeth part of the grooves which is highly desirable for the efficient conversion of the mode. This highly efficient designed transition will be very useful for developing the microwave plasmonic metamaterial based integrated circuits.

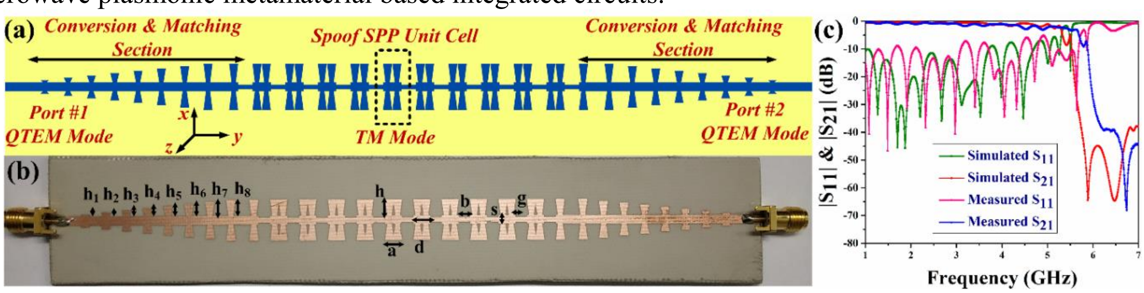

Figure 1. (a) Proposed design of the back-to-back transition from QTEM mode of the microstrip to the highly confined TM mode of the spoof surface plasmon polaritons.

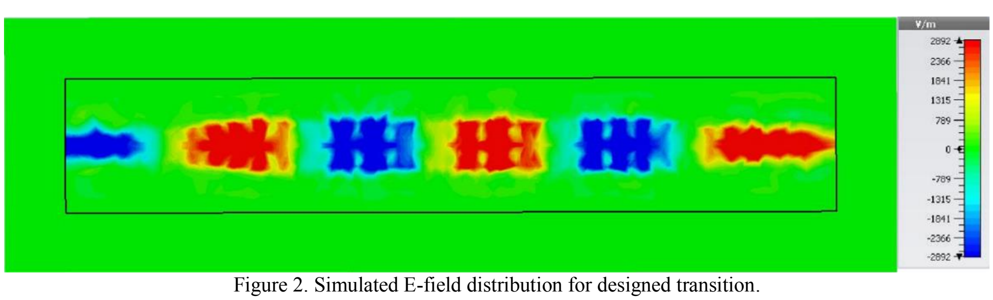

Figure 2. Simulated E-field distribution for designed transition.