ABSTRACT

This thesis work reported in this thesis is focused on developing Spoof Surface Plasmon Polariton (SSPP) based antennas and their application in planar wireless communication systems. Some novel grounded SSPP-based antennas are designed and demonstrated in this thesis. The major advantage of realizing a microstrip-to-grounded SSPP transition is ease of integration with other RF devices and circuits because the ground is needed for proper operation of these devices. The grounded SSPP-based transitions find application in realizing passive microwave circuits such as filters, and the realization of short or open-circuited stubs. Poor grounding degrades the transmission of a signal and leads to unwanted radiation. Also, an amplifier possessing high power gain requires a good grounding to suppress feedback (output to the input) signal to prevent oscillation. The advantage of using grounded SSPP is that microwave active and passive circuits can be easily integrated with the microstrip and CPW technology.

A wide-angle forward-to-backward scanning wideband leaky-wave antenna (LWA) based on the microstrip spoof surface plasmon polaritons (SSPPs) transmission line (TL) is proposed. The proposed microstrip SSPPTL has tapered corrugations on both sides of the metallic strip conductor. After designing an efficient transition with a good transition occupation ratio and excellent transmission efficiency, a wide-angle scanning LWA is realized. A methodology of achieving high gain and wide-angle scanning by adjusting a large number of radiating elements in a compact area is proposed. The proposed antenna operates in the frequency range of 8.9–12.7 GHz having fractional bandwidth of 35.18% with a continuous scanning range from −35° to +51°. Maximum gain of 19.03 dBi with maximum radiation efficiency of 90% is achieved from the structure. The proposed antenna can easily be integrated with planar wireless communication systems due to the presence of an unbroken ground plane.

A wideband transition from a microstrip transmission line to a microstrip spoof surface plasmon polariton (SSPP) transmission line is reported next. The proposed transition is realized to achieve better performance starting from low frequencies up to 40 GHz. The proposed shape of the unit cell is taken in such a manner that the momentum, impedance, and polarization of the microstrip line can be matched with that of the SSPP transmission line. The wide operating band of the transition can be achieved by perturbing only the shape of the unit cell. Extra care is taken in choosing the shape of the unit cell so that the fabrication of the circuit becomes easier, especially at millimeter-wave frequencies. The proposed transition offers good

transition-occupation ratio and transmission efficiency. The achieved transition-occupation ratio and transition efficiency for all three designed cases are excellent, and it is 34.18%, 44%, and 39% for p = 1 mm, 2 mm, and 3 mm, respectively. It is a potential candidate for realizing millimeter-wave antennas and devices due to its attractive properties, such as compact layout, low fabrication cost, ease of fabrication even at millimeter-wave frequencies, and good operational characteristics.

Frequency scanning antennas realized by loading the radiating elements on both sides of the microstrip, asymmetrically corrugated spoof surface plasmon polariton (SSPP), and symmetrically corrugated SSPP transmission lines are also discussed in this thesis. Both traveling and standing wave antennas are considered and performance in terms of S-parameters, radiation pattern, scan range, and gain is reported. Additionally, the crosstalk between two transmission lines is observed in all cases. Based on the analysis, it was proved that the crosstalk was minimum in the case of symmetrically corrugated SSPP transmission lines. The proven advantages of the SSPP lines are better signal integrity, high gain and wide-angle scan in frequency scanning antennas.

An electronically tunable band-notched behaviour obtained from the slot-loaded spoof surface plasmon polariton (SSPP) transmission line is also presented in this thesis. The band-notched characteristic has been achieved after inserting a slot resonator into the SSPP transmission line. A single tunable notch in the frequency range of 3.5-10.5 GHz or dual tunable notches in the frequency range of 3.5-6 GHz and 6-10.5 GHz have been achieved after incorporating varactor diodes across the slots. The proposed idea is verified through circuit analysis, simulations, and then measurements. Further, the proposed concept is extended to demonstrate an ultra-wideband antenna with a switchable band-notched behaviour. The proposed slot-loaded SSPP-TL is suitable for easy integration with other active and passive devices due to its dual conductor structure.