Abstract—The use of substrate integrated waveguide (SIW) technology in integrated microwave circuits has increased significantly in the last few years. The SIW technology has been used to design phase shifters, oscillators, filters and cavity backed antennas. SIW waveguides show similar characteristics as that of rectangular metallic waveguides but with more advantages like low fabrication cost, light weight etc. This paper reviews the use of SIW technology in the design and fabrication of SIW waveguides, SIW slot antennas and SIW slot array antennas.

Index Terms—substrate integrated waveguide, slot antennas, slot array antennas, microwave circuits

I. INTRODUCTION

In the last few decades, the substrate integrated waveguide (SIW) technology has been used in a wide range of applications like radars, biomedical devices and mobile communication [1].

The SIW is a rectangular waveguide like structure, which is fabricated by embedding two parallel rows of conducting cylinders or vias in a dielectric substrate [2]. The SIW supports only TE\textsubscript{00} modes propagation. The TM mode does not propagate through SIW because of the discontinued current flow along the conducting cylinders. The dispersion and propagation characteristics of SIW are similar to rectangular metallic waveguides [2].

SIW provides several advantages over general purpose rectangular waveguides like low fabrication cost, small size, light weight etc. Due these advantages, the SIW has been used to design filters, oscillators, phase shifters, attenuator and various antennas [1]. This paper summarizes the growth of SIW technology in the field of SIW waveguide and SIW slotted array antennas.

II. RECENT PROGRESS IN SIW ANTENNAS

The development of low cost and light weight fabrication of rectangular waveguide has led to the rapid growth of SIW waveguide. Due to the use of planar printed technology in fabrication of SIW antennas and waveguides, SIW has been used extensively in integrated microwave circuits.

In 1998 the original SIW design originated and was known as laminated waveguide or post wall waveguide [1] [2]. A slot cut on top of metal surface of SIW structure interrupts the current flow and couples the power from waveguide into free space, similar to that for a waveguide fed slot [2]. The theoretical analysis of metallic waveguide fed slot as a boundary value problem has been done by Stevenson [5]. Later on, the design theory for slot array antenna was presented by Elliott [6] [7-9]. Figure 2 shows the dual frequency longitudinal slot array antenna [10].
Table 1 shows the comparison of existing literature on SIW slot antennas and compares different parameters like feeding technique, frequency range and method of analysis used during simulation in software.

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Feeding Technique/ Geometry</th>
<th>Frequency range (GHz)</th>
<th>Software (Method of Analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Microstrip Line</td>
<td>8 to 12 (X-Band)</td>
<td>HFSS (Finite Element Method)</td>
</tr>
<tr>
<td>11</td>
<td>Coaxial Feeding</td>
<td>8 to 12 (X-Band)</td>
<td>HFSS (Finite Element Method)</td>
</tr>
<tr>
<td>6</td>
<td>2×4 longitudinal slots</td>
<td>9</td>
<td>Method of Moments</td>
</tr>
<tr>
<td>12</td>
<td>L- shaped Slot</td>
<td>10.84 to 11.01 &amp; 12.60 to 12.78</td>
<td>HFSS (Finite Element Method)</td>
</tr>
</tbody>
</table>

Table 1 Comparison of Existing literature on SIW Slot Antennas

In 1978 Elliott and Kurtz have presented theory for designing of slots array. They have also designed and experimentally tested the two-by-four slot array at 8.930 GHz. The SIW waveguide has been fabricated by using Roger’s 4350B substrate with microstrip line feeding; the waveguide provides measured insertion loss below 6 dB and return loss is less than 10 dB [4]. The work has been proposed with coaxial feeding SIW waveguide; which shows measured insertion loss of 1.2 dB and return loss of -15 dB [11]. The L-shaped slot has been designed and implemented for dual band frequency range of 10.84 GHz to 11.01 GHz and 12.60 GHz to 12.78 GHz [12].

To increase the overall gain and to reduce the side lobe level slot array antennas has been used. Table 2 shows comparison of existing literature on SIW slot array antennas. Li Yan and Wei Hong has designed four-by-four longitudinal slotted array operating at 10 GHz by using Elliott’s procedure with uniform aperture distribution [15]. Two one-by-four slot linear array has designed and implemented using RT Duroid 5880 resonates at lower frequency of \( f_1 = 8.6 \) GHz and higher frequency \( f_2 = 10.8 \) GHz with a gain of 7.7 dB and 9 dB respectively [14]. To obtain low back lobe and side lobe in array design is the big challenge. But with com-shaped choked method with quarter-wavelength short-end parallel microstrip lines at the bottom surface of two-by-four slot array; shows significant 5.6 dB reduction in back lobe with 0.4 dB improvement in gain [13].

### III. CONCLUSION

The growth in the use of SIW technology in field of slot antennas has been summarized in this paper. The advantages of SIW technology have been compared with the conventional waveguides. The different types of feeding technique used impedance matching are enlisted and compared in this paper.

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### REFERENCES


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