Kapton Flexible Technology for V-band Applications

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ABSTRACT

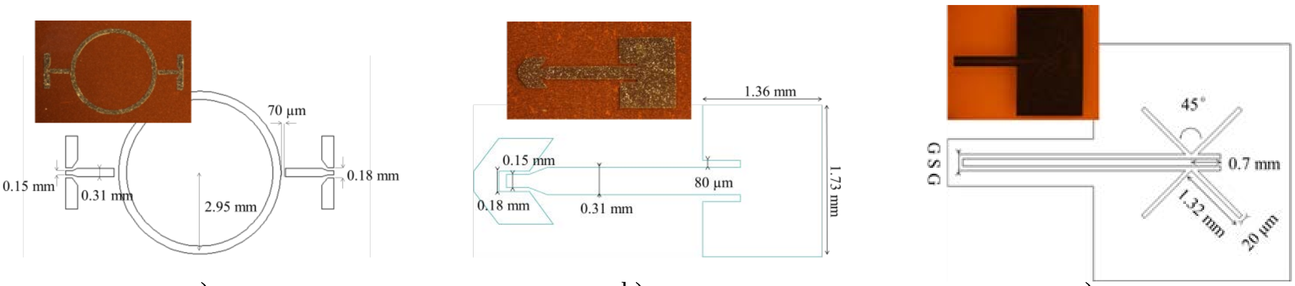
This paper addresses the flexible Kapton technology for V-band applications. The proposed technology allows a fabrication accuracy down to 6 µm with insertion losses in the range of 0.5 dB/mm for coplanar waveguide lines at 60 GHz. Based on measurements results, the impact of humidity on the Kapton is quantified in the millimeter wave spectrum and V-band with the help of dedicated passive devices: ring resonator and antennas. An assembling process is also proposed in order to integrate active devices on flexible supporting Kapton board.

I. INTRODUCTION

Nowadays, there are increasing demands for flexible and wearable electronics. Also the targeted frequency dedicated for emerging applications increases. The millimeter spectrum and especially V-band are now addressed for short-range and high bit-rate communications. For such high frequencies, Kapton flexible substrate has become a trusted candidate. The Kapton exhibits: good RF and thermal properties, very good flexibility over a wide temperature range and good tolerance for many chemical solvents. This paper focus on the recent advances in the development of Kapton flexible technology for V-band applications. Exhaustive investigations of the Kapton behavior in V-band including the quantified impact of the ambient humidity are presented. An assembling process of electronic chips by heterogeneous integration on flexible Kapton is also proposed.

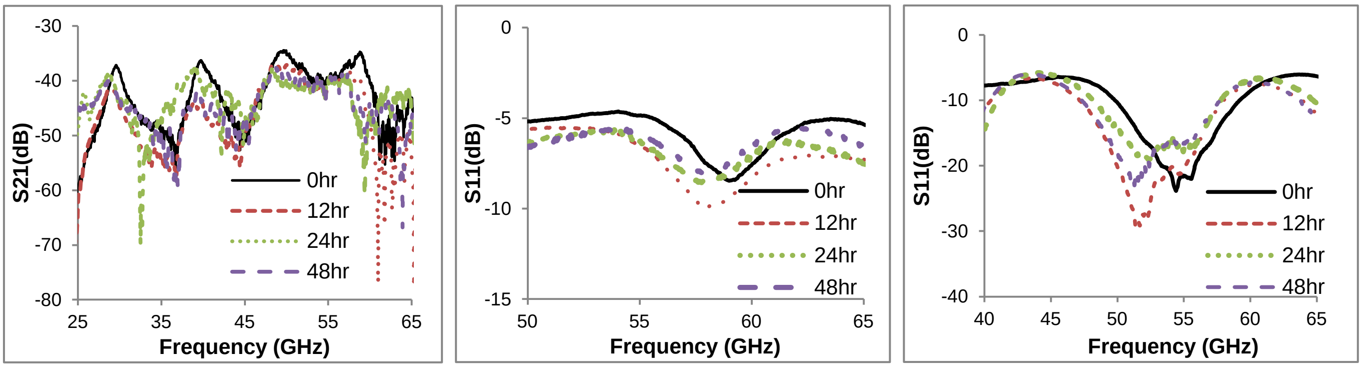
II. V-BAND HUMIDITY MEASUREMENT OF KAPTON

Three passive devices were selected as benchmark for this technology: a ring resonator, a microstrip patch antenna and a crossed slot dipole antenna. All above mentioned devices, represented in Fig. 1, are appropriate for humidity tests due to their intrinsic sensitivity to dielectric property variation.



a) b) c)

Fig. 1. a) Ring resonator; b) Microstrip antenna; c) Crossed slot dipole antenna



a) b) c)

Fig. 2. Measured S parameter of a) ring resonator; b) microstrip antenna and c) crossed slot dipole antenna

The humidity test method is based on IPC-TM-650 2.6.2.1 standard technique [1]. The test samples were firstly dry out in an oven for over 30 minutes at 150 °C, each of them was individually weighed immediately. Then the test samples were immersed in a crystallizing dish filled with deionized water for 12 hours (hr). Each sample was removed independently from the water and sprays dried with nitrogen and weighed again. The same process was repeated for 24 hr and 48 hr respectively. The weight was increased with 1.64% after 12 hr, 1.78% after 24 hr and 1.81% after 48 hr.

The S-parameters measurements were carried out right after the weighing of the samples. Fig. 2 shows the results obtained for the ring resonator, the patch antenna and the crossed slot dipole antenna. The extracted values for the relative dielectric permittivity are reported in Table I. taking into account the associated tolerances.

Time	ε_r	Tolerance of ε_r	tanδ	Tolerance of tanδ
0 hr	3.2	+/- 0.08	0.016	+/- 0.005
12 hr	3.4	+/- 0.06	0.03	+/- 0.008
24 hr	3.6	+/- 0.08	0.04	+/- 0.006
48 hr	3.7	+/- 0.09	0.045	+/- 0.008

TABLE I. EXTRACTED DIELECTRIC CONSTANT AND DIELECTRIC LOSS

III. FLIP CHIP ASSEMBLING TECHNIQUE

For the purpose of integration of different components on Kapton polyimide, different dummy circuits were mounted by using a flip chip technique [2]. Four probe method was used to characterize the bumps resistivity as shown in Fig. 3.a). A resistance about 10 mΩ was measured for the gold bump, which proves a very good DC contact.

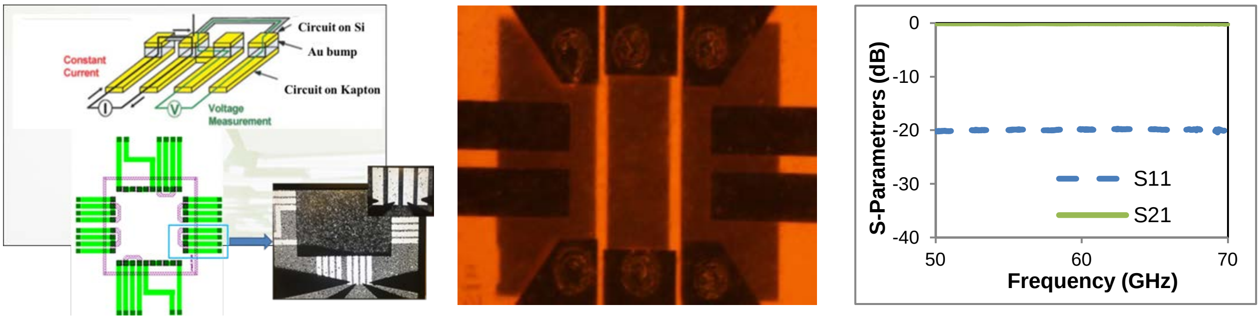


Fig. 3. a) Four probe measurement; b) 50 Ω CPW transmission line mounted on Kapton; c) Measured S-parameters of CPW transmission line with flip chip mounted transition

For the RF performance evaluation, a 50 Ω CPW transmission line on was mounted on Kapton as shown in Fig. 3.b). The measurement results of S-parameters show us a good RF performance in Fig. 3.c).

VI. CONCLUSION

In this paper, several resonant passive devices were fabricated on Kapton flexible substrate. A standard humidity test was performed in V band. The experimental results demonstrates that the dielectric constant of the Kapton increases with maximum 15.6 % (up to 3.7 from 3.2 the initial value) and the dielectric losses increases with maximum 181% (up to 0.045 from the initial value of 0.016) when the Kapton structure were immersed in water after 48 hours. A limitation of the water absorption was also observed after 24 hours of the water immersion. The DC and RF measurements of dummy circuit mounted with flip chip technique show very promising results for a future 3d heterogeneous integration.

REFERENCES

[1] https://www.ipc.org/TM/2-3_2-3-25-1.pdf

[2] M. M. Jatlaoui, D. Dragomirescu, M. Ercoli, M. Krämer, S. Charlot, P. Pons, H. Aubert, and R. Plana, "Wireless communicating nodes at 60 GHz integrated on flexible substrate for short-distance instrumentation in aeronautics and space," *International Journal of Microwave and Wireless Technologies*, vol. **4**, pp. 109-117, 2012.