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Tunable Phase Shifter Based on LTCC Microfluidic Device

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Abstract

In this work, we present a tunable phase shifter based on microfluidic technology. The idea consisted in to use different fluids to change the permittivity underneath a microstrip line, changing the phase from an electromagnetic wave. The device will be microfabricated using LTCC ceramic technology, a substrate developed for RF devices and also suitable for microfluidic devices. We present in this moment the computational studies for fluid flow control and the change of S_{21} phase as the variation of fluids portion inside the microchannel. The results are promising and show that microfluidic will be also a tool for electromagnetic wave modulation.

Keywords—phase shifter, electromagnetic waves, microfluidic, LTCC technology.

Introduction

In recent years, the possibility to use fluids to manipulate electromagnetic waves for different uses presents an interesting area not very well explored. Some works presents microfluidic sensors using electromagnetic waves in the RF and microwave region of spectrum to detect microfluidic droplets sizes. By observing the difference in electrical permittivity of the fluids it is possible to perform size measurements. Besides, the use of microwaves could heat substances in a localized area promoting controlled chemical reactions in few minutes.
Nowadays, the use of microfluidic has been used to tune microwave circuits and antennas have been studied. Depending on the fluid characteristics it is possible to change the permitivitty on the microstrip line, and change the phase signal. Different fluids could be used inside the microchannels to tunning electromagnetic waves and applications such as phase shifters, filters and antennas have been researched .
In this work it is proposed a designed of a tunable phase shifter using microfluidic device technology. By controlling the portion of two fluids inside the microchannels, we observe the variation of electromagnetic phase signal.

Boybay, M.S.; Jiao, A.; Glawdel, T.; Ren, C.L. Microwave sensing and heating of individual droplets in microfluidic devices. *Lab Chip*, **13**, 3840-3846, (2013).
Yesiloz, G.; Boybay, M.S.; Ren, C.L. Label-free high throughput detection and content sensing of individual droplets in microfluidic systems. *Lab Chip*, **15**, 4008-4019, (2015).

Device Design and Microfabrication Process

The different layers for the microfluidic phase shifter is illustrated in Fig. 1. In Fig.1 (a) We have the design of microchannel, which the main channel was designed to have 1.5 mm of width and 6 cm of length, containing two inlets and one output on the same layer, Fig 1(b). The thicknesses will be determined by the LTCC, and it was choosed the ceramic with 165 um in the green state. Microstrip transmission lines will be fabricated by depositing 10 µm-thick copper films on both sides of the LTCC device. These transmission lines were designed to have 700 um in width in order to have 50 W of characteristic impedance, Fig. 1(c). And in Fig 1 (d) the final microfluidic device qwith a glass slide over the output fluid.
Two syringe pumps will be used to control the fluids flow inside the channels. Fluids such as air, water, ethylene glycol and others will be tested in this device with typical flow rate around 1 to 10 uL/min.

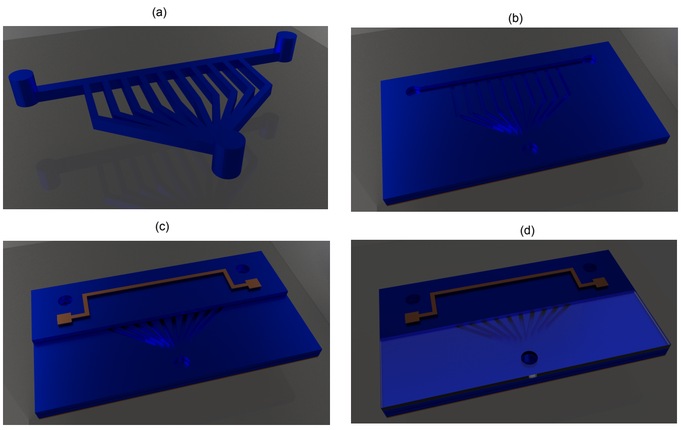

Fig.1 Microfabrication steps for LTCC microfluidic phase shifter: (a) base with copper ground contact, (b) microchannels design geometry, (c) microstrip line over the main microchannel and (d) glass slides over the part of channel – complete device.

Acknowledgment

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Fluids Beahavior

Different fluids were tested in the microchannels in order to observe the flow control inside the channel. By combining two fluid flows it is possible to control the portion of them, in order to promote different permittivity underneath the microstrip. Water, machine oil, air, soybean oil and ethylene glycol were used on the firsts tests. In the Fig.2 is shown the example with soybean oil (red) and ethylene glycol (blue) for different flow ratios as follows: (a) 1:1 cm/s, (b) 1:5 cm/s and (c) 1:10 cm/s.

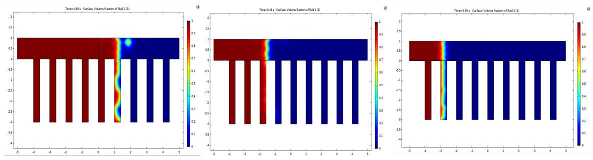

Fig. 2 The use of soybean oil (in red) and ethylene glycol (in blue) with different fluid flow ratio: (a) both with the same velocity (cm/s), so 1:1 ratio; (b) ethylene glycol five times higher than soybean oil, 1:5 and (c) ten times higher, 1:10.

HFSS Studies

We conducted the HFSS Studies considering a frequency of 30 GHz. In the Fig. 3 (a) is shown the design simulated. As can be seen, the fluid flows along the channel between the microstrip and ground contact. In the Fig. 3(b) is shown the graph (b), obtained with numerical simulations, of the phase of the S_{21} parameter as a function of ethylene glycol fraction along the microchannel. As can be seen, as the ethylene glycol portion was higher and filled the microchannel, the phase absolute value varies.

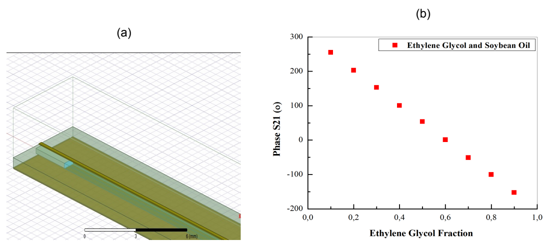

Fig. 3 HFSS computational studies: (a) a portion of ethylene glycol inside the microchannel, flowing between microstrip line and ground contact and (b) Phase S_{21} variation with the change of ethylene glycol portion inside channel.

Conclusion

We can observe that the microfluidic technology will be also a tool for RF and Microwave Devices, allowing signals modulation. The first results shown a prove of concept, using ethylene glycol and soybean oil inside the channel to change the phase. This work is still in the beginning and the device is under microfabrication process.