8-8-2007

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Chen, Chung-Hao; Whalen, John; and Peroulis, Dimitrios, "Non-Toxic Liquid-Metal 2-100 GHz MEMS Switch" (2007). *Birck Poster Sessions*. Paper 15.

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1. Motivation

The first liquid-metal shunt capacitive switch has been demonstrated

- for high power applications
- < 0.05 dB insertion loss at 2-20 GHz
- >20 dB isolation at 20 GHz

However, the liquid metal used is mercury which is toxic and not environmental friendly

Objective:

- Search potential substitutions for mercury
- Design switches with comparable RF performance

2. Design Idea

Replace mercury by non-toxic liquid metal — Galinstan (Ga/In/Sn)

	Mercury	Galinstan
Conductivity (S/m)	1.04×10^6	2.3×10^6
Melting point (°C)	-38.83	-19
Boiling point (°C)	356.73	1300
Viscosity (Pa·s)	1.53×10^{-6}	2.4×10^{-6}
Density (g/cm ³)	13.5	6.4

4. Complete Device

3. Galinstan Slug Movement

Challenge:

Galinstan oxides quickly in air
Its oxide adheres to almost every surface

Solution:

Immerse Galinstan in Teflon solution (Teflon AF)

No traces were found when Galinstan moved

5. RF Performance

Loss budget:

	CPW	CPW+PDMS	CPW+PDMS+Teflon	Extracted switch loss
20GHz	0.12	0.23	0.2	0.08
40GHz	0.51	0.71	0.66	0.15
100GHz	0.81	1.7	1.28	0.47

unit: dB

Insertion loss:

<0.5 dB up to 100 GHz including packaging

Teflon solution is transparent in the microwave region

Isolation:

>20 dB at 20-100 GHz

~180-nm Teflon solution layer between Galinstan and CPW