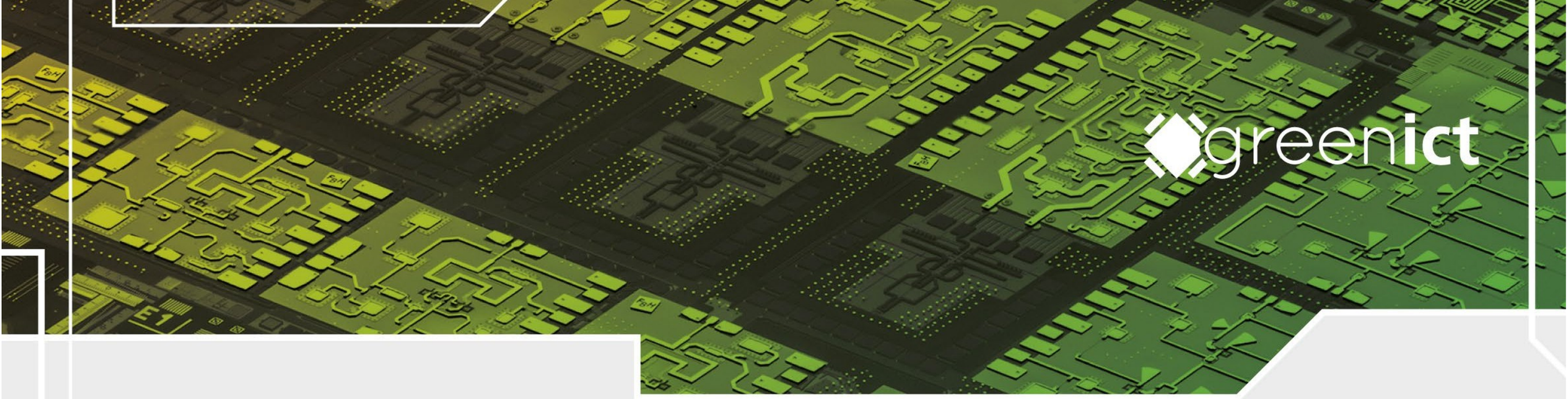


Reduced PFAS in MEMS

Reduction of PFAS (PTFE) in microsystems by using another hydrophobic alternative (FDTS)

1

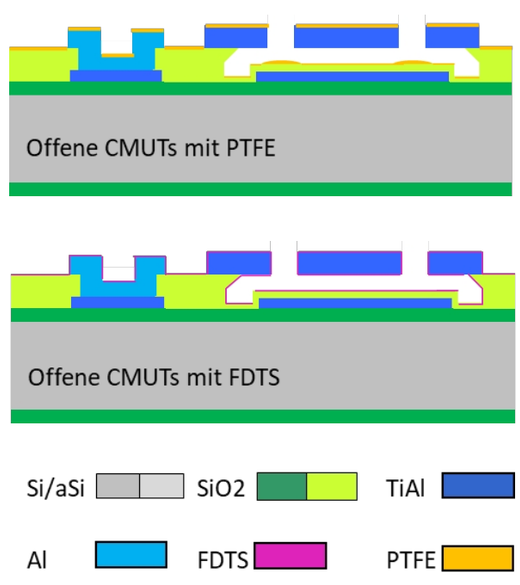
A fundamental problem of MEMS devices that are operated in the atmosphere is the oxidation and moisture absorption of the active structures. To control this, it is common practice to use PTFE (Teflon) as a hydrophobic layer.
In order to reduce or replace environmentally toxic materials in microelectronic processes, the extent to which the PTFE previously used in the process and performance of CMUT components can be replaced by FDTS was investigated as an example.

2 Challenges

A key evaluation criterion for CMUTs is the resonant frequency and the pull-in voltages. These are directly dependent on the mechanical conditions of the vibrating CMUT plate. A change from PTFE to FDTS changes these conditions and was carefully investigated.

3 Process section and trials

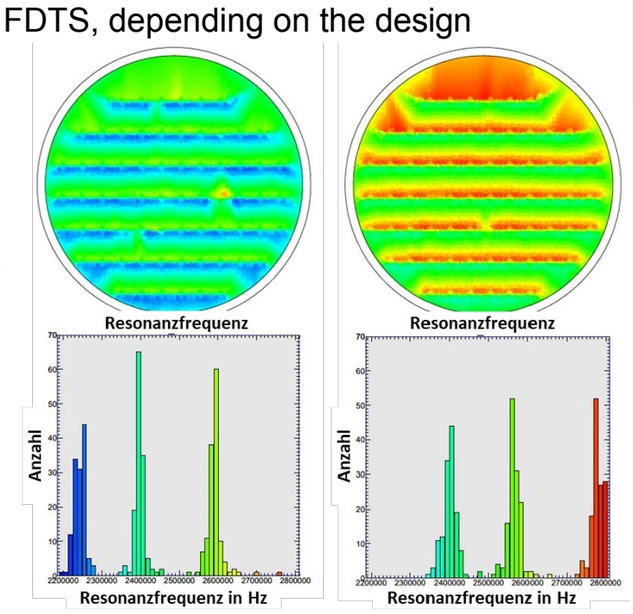
IPMS manufactures a large number of different CMUT variants that have defining characteristics depending on the application. One of these applications is air-coupled CMUTs. In this design, the vibrating CMUT plate has holes in order to achieve additional damping through the atmosphere in the cavity and thus a lower resonance frequency. The lower frequencies result in a lower attenuation of the signal and therefore a higher effective range.
The directionally deposited PTFE with 100 nm was exchanged for ALD-processed FDTS with a few nanometers. This resulted in a completely uniform coating of the CMUTs.
The PTFE deposited so far has increased the vibrating mass and contributed to reducing the frequency. The resulting shift in frequency must be investigated and adjusted.



4 IntroductionComparison and evaluation of results

Wafer level measurement data with sufficient statistical significance is available for the ultrasonic component with PTFE and FDTS. The resonant frequency increases by 4.4 % to 7.8 % by substituting PFTE for FDTS, depending on the design variation.

This shift is shown in the wafer maps of characterized CMUTs on the left. The resonance frequencies measured with PTFE are shown on the left and with FDTS on the right. In each case, three different designs were processed and characterized, which showed clearly identifiable peaks or
shift to higher frequencies in the frequency distribution.



This means that the expected shift due to the alternative use of materials can be transferred to similar designs.

FDTS is deposited by atomic layer deposition in an MVD300 system from SPTS. The design correction has now been implemented and confirmed in several development batches produced on behalf of industrial customers.

5 Summary

Larger material additions require changes in the process, which vary the functional characteristics of the CMUTs.
The changes can be corrected by adjusting other design parameters. This allowed the volume of PFAS materials used to be significantly reduced without affecting the function of the component.

Outlook

We are currently investigating which materials can be used as a substitute for FDTS in order to process CMUTs completely PFAS-free.
The findings were successfully transferred to other MEMS at IPMS.

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