electrically conductive adhesives

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Abstract

The present study presents the development and comparison of two foil-to-foil lamination and interconnection methods of foil-based capacitive humidity sensors. The first method uses confined anisotropic conductive adhesive (ICA) in laser ablated vias through foil (TFV). The second method uses anisotropic conductive adhesive (ACA). Both integration methods were characterized during accelerated humidity (85°C / 85 R.H.),shock temperature (-40°C / 125°C) and bending forces. While the ACA method requires less processing steps and the TFV method was shown to be more robust to bending forces, the interconnection of both methods withstood more than 900 hours of environmental ageing. Finally, the correct functionality of two types of foil-based capacitive humidity sensors was successfully demonstrated by exposing them to different R.H. levels and comparing their readings to a commercial sensor.

1. Face-down approach

The approach used to interconnect the sensors to the tracks on the target substrate is the so-called face-down approach with sensor access window..

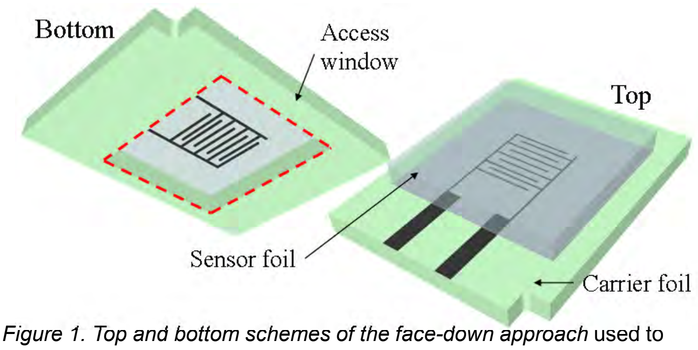

Figure 1. Top and bottom schemes of the face-down approach used to interconnect the interdigitated capacitive sensors.

2. Process flow and characterization

Through Foil Vias (TFV)	ACA
• Laser ablation of dry adhesive • Lamination of dry adhesive • Vias filling (screen printing) • Window laser ablation • Final alignment and lamination	• Window laser ablation • ACA stencil printing • ACA curing (10 sec @ 90 °C) • Final alignment and lamination

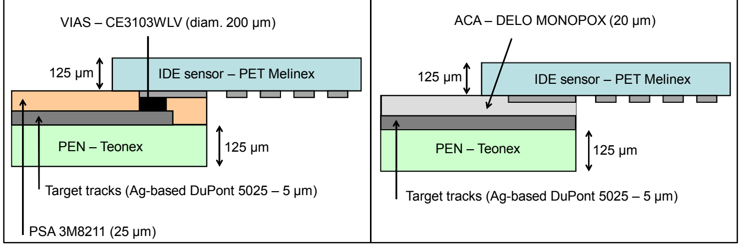

Figure 2. Process steps for TFV and ACA integration techniques.

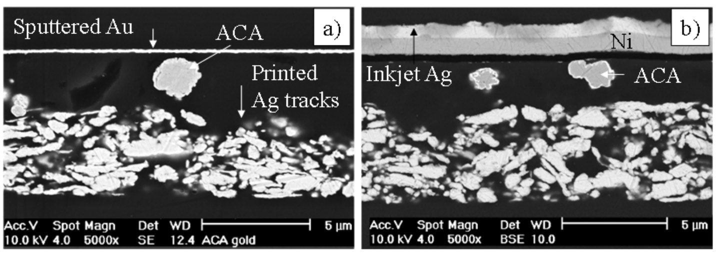

Figure 3. SEM cross-section of a) Au-sputtered and b) Ag-printed humidity sensors integrated with ACA..

3. Environmental and humidity tests

Accelerated humidity and shock tests were performed for the ACA and TFV methods to evalute their robustness. Additionally, the respose of the integrated humidity sensors was compared to a commercial sensor.

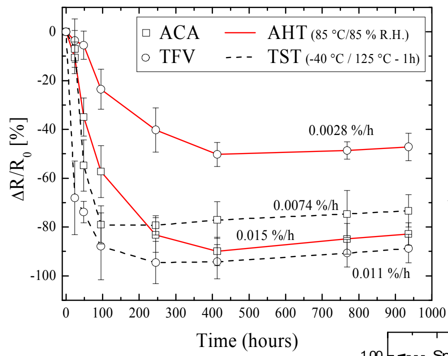

Figure 4.
TST
Reduction might be due to extra contact points caused by reallocation of conductive fillers.

AHT
Reduction might be due to extra ions improving the percolation paths between conductive fillers.

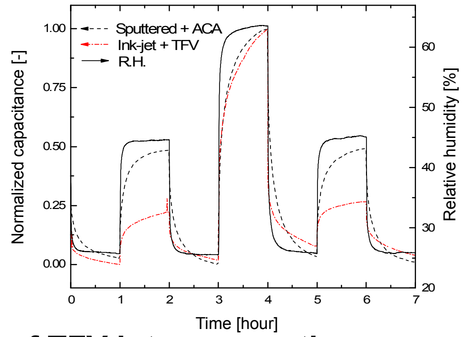

Figure 5. Under humid conditions, the sensor's normalized capacitance changes were compared to R.H. values from a commercial sensor, where the expected response was always achieved.

4. Implementation of TFV interconnections

TFV interconnections were successfully implemented at foil-to-foil level in an RFID smart label at Holst Centre / TNO. Figures 6a and b show pictures of the complete tag and a close-up on the interconnection and access window.

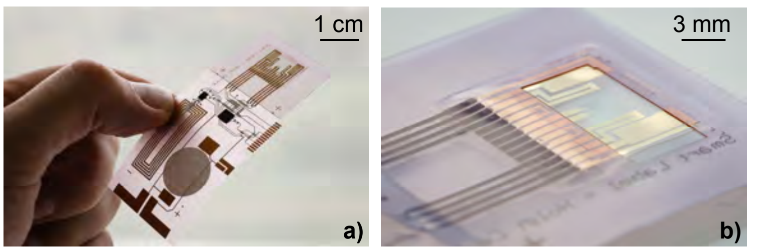

Figure 6. a) RFID smart label interconnected to a sensor foil using the TFV method b) Close-up of the access window and TFV interconnections.

5. Summary

Two methods were used to interconnect the sensors: through foil vias (TFV) and anisotropic conductive adhesives (ACA). Both interconnection methods proved to be robust after bending and environmental tests. Finally, the functionality of the interconnections was successfully demonstrated after exposing the sensors to different humidity levels and comparing their results to a commercial sensor. The TFV method was demonstrated by interconnecting a sensor foil to an RFID smart label at Holst Centre / TNO.

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FP7-Marie-Curie Initial Training Network (ITN), *FlexSmell* , www.flexsmell.eu, *Gas sensors on flexible substrates for wireless applications,* Grant no. 238454.

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