



# Versatile Materials for Wide-Ranging Applications of Colorimetric and Electronic Detection of Chemical Warfare Agents

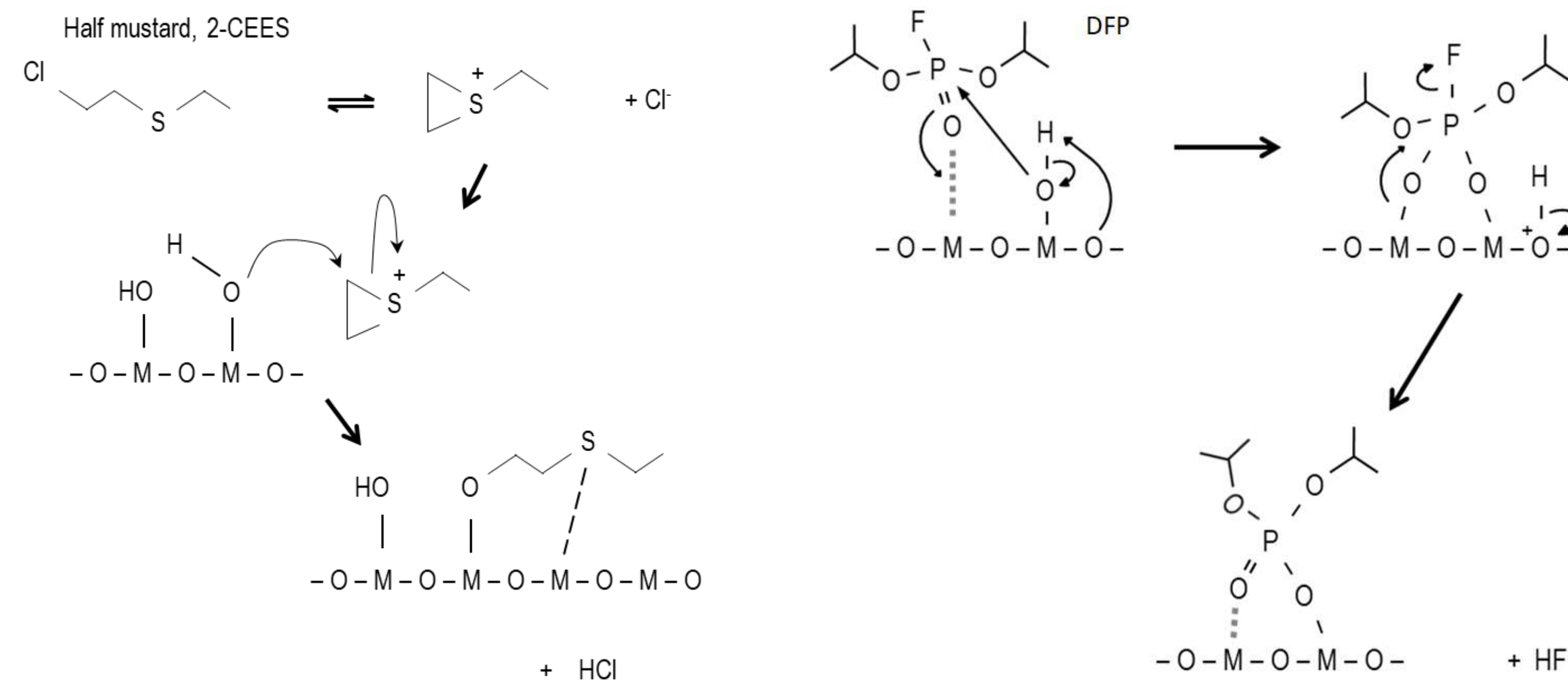


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## Background

DEVCOM CBC scientists are researching and continuing to develop novel materials for chemical warfare agent (CWA) sensing. Our investigation into cation-exchanged zeolites has shown them to have promise as a material with properties which can be leveraged for both colorimetric and electronic CWA sensing. We have identified three different species which provide different colorimetric responses to different classes of agent. Many different form factors have been developed using these materials including but not limited to powders, surface coatings, free-standing films, and paints.

## Mechanism



By varying the species of cation exchanged into the porous crystalline materials, the color and reactivity of the colorimetric materials is tuned for unique responses to different threat chemicals of interest.

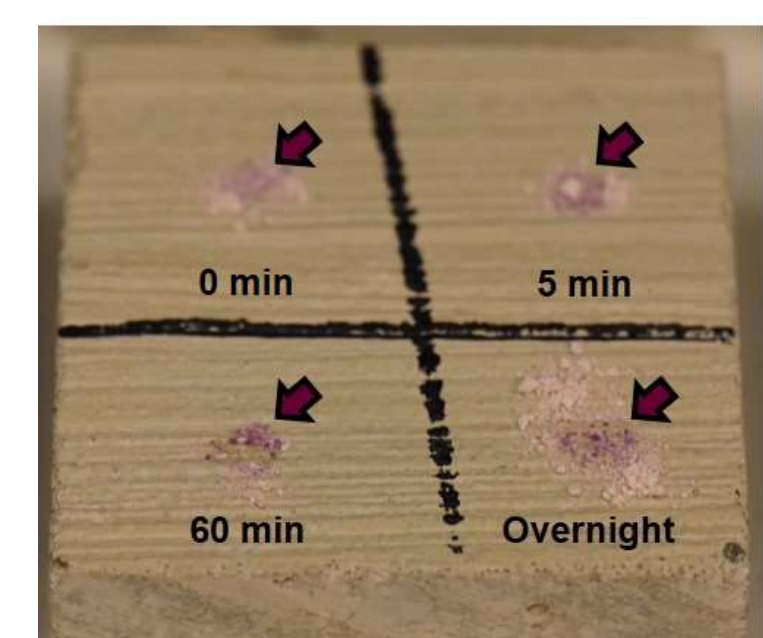
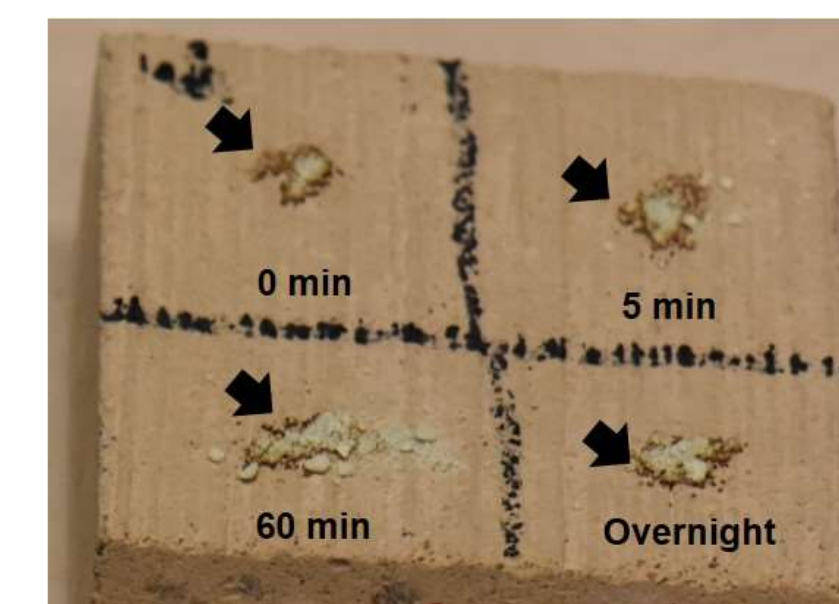
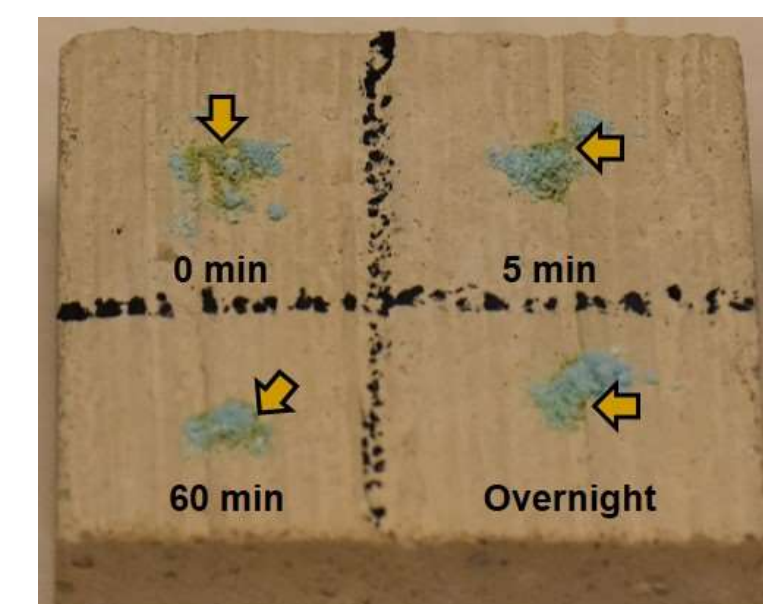
## Neat Liquid Detection

Screening against three common classes of agent shows unique colorimetric responses for each class:



- Type 1 agents will turn the blue materials to yellow-green
- Type 2 agents will turn the green materials to brown
- Type 3 agents will turn the pink materials to deep purple
- Type 4 agents will turn both the green materials brown and the pink materials to deep purple

In addition to powders, the materials are easily integrated into free-standing films which retain the colorimetric response. Varying the polymer makeup of the films can vary the flexibility and adhesive properties of the individual films.

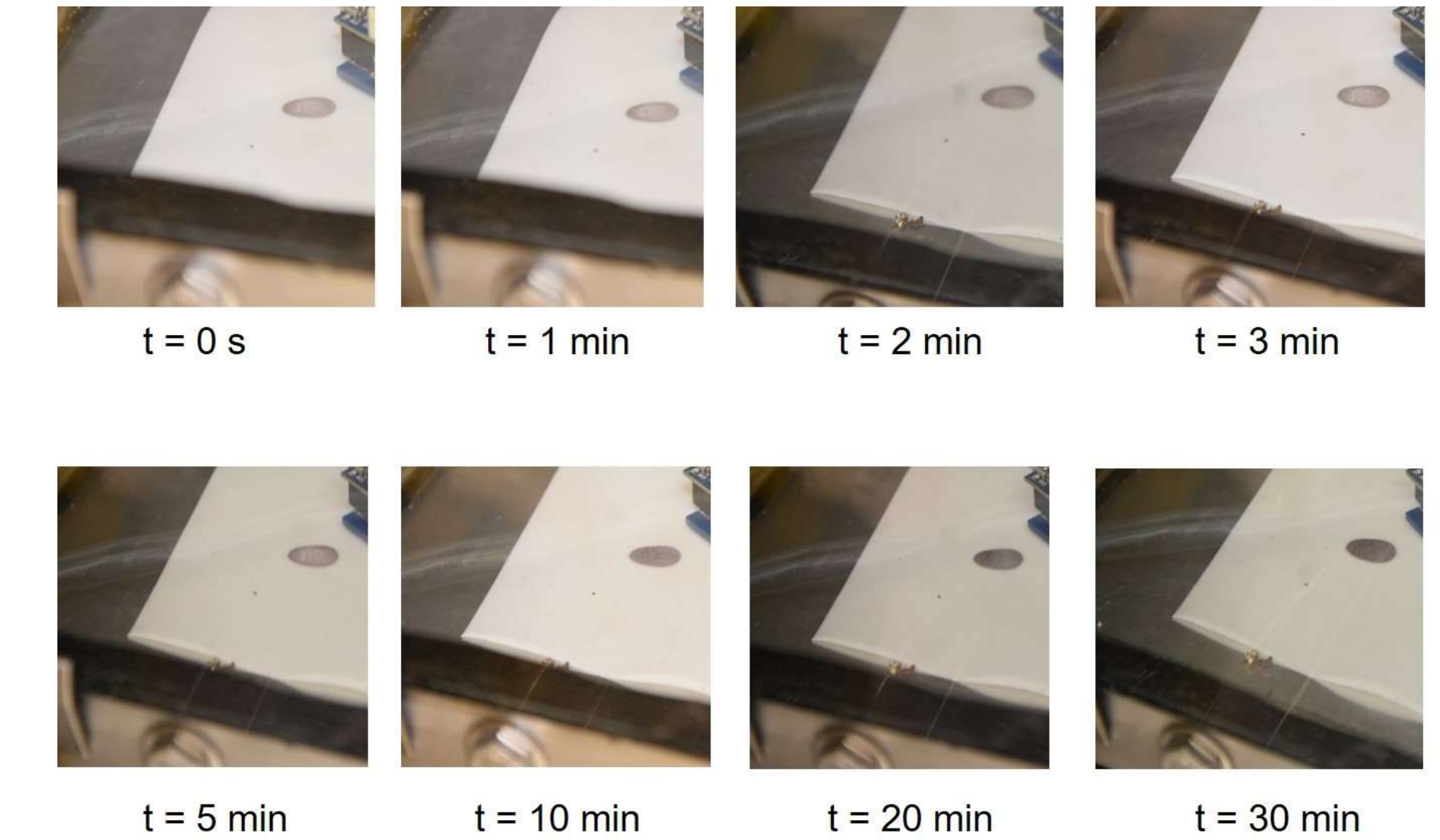


A time-response study of the ability of the ability of the materials to respond to absorbed agent was carried out. 10  $\mu$ L droplets of neat liquid agents were drop-cast onto porous concrete substrates at t=0 minutes. The relevant detection material was then deposited onto the same spots at (starting from top left):

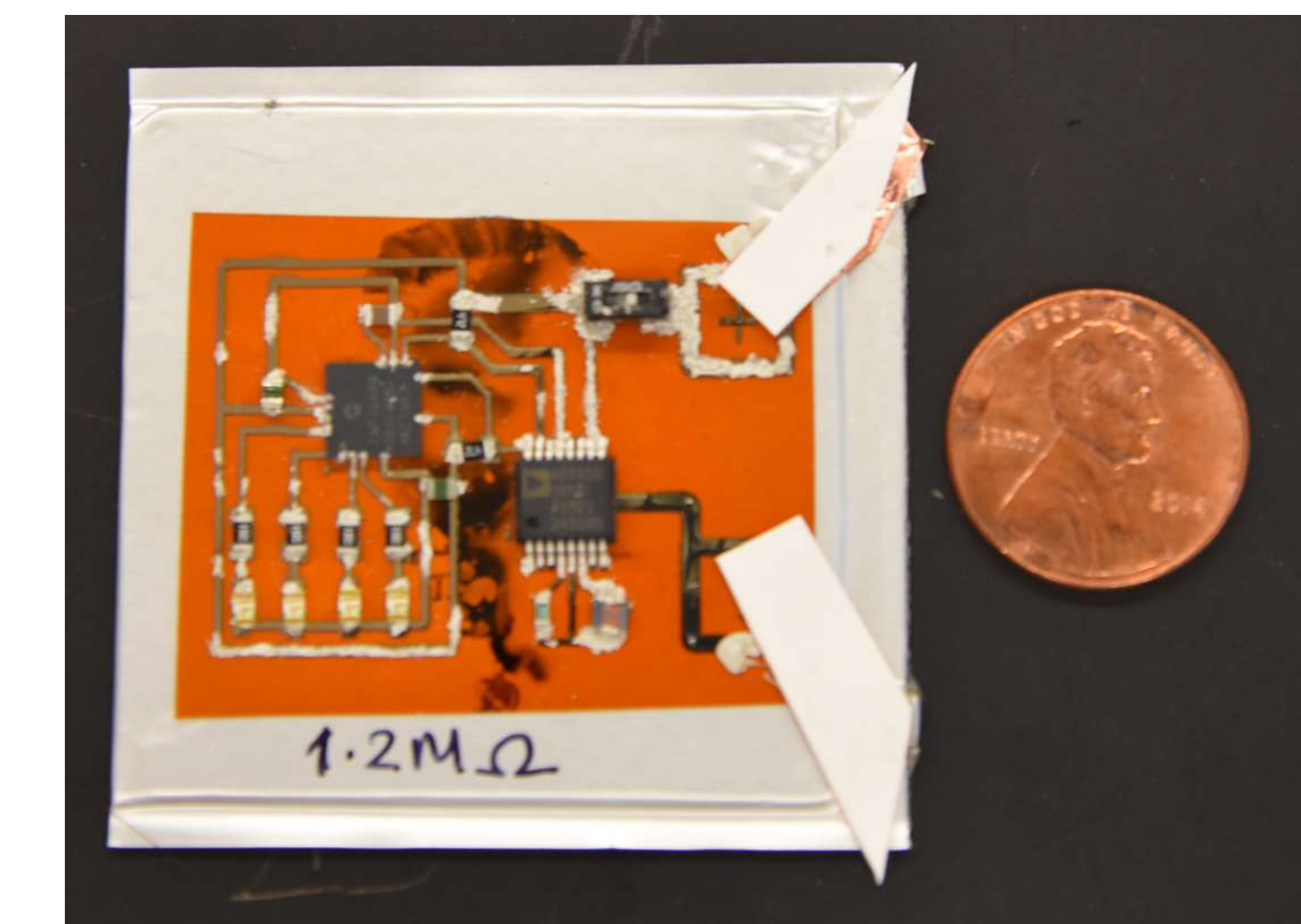
- t=0
- t=5 min
- t=60 min
- t=1 day

The materials were still able to absorb and respond colorimetrically to the residual agent

## Vapor Detection



Timelapse of drop-cast pink materials exposed to 11 ppm agent environment. Current fielded colorimetric liquid detection papers do not also respond to vapor. Work is ongoing to increase sensitivity and response times to meet toxicological requirements.



Materials integrated into compact circuit IDC for measuring changes in impedance based on chemical exposure. Response to saturated CWA vapor was recorded in under 5 seconds.

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