COMBATING REVERSE ENGINEERING THROUGH TRANSIENCE

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NDIA Trusted Microelectronics Workshop

August 16, 2016

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The DARPA solution is to provide a menu of hardware security options that can be selectively applied based on need

			Microelectronics Security Threats				
	Protection	*Program*	Loss of information	Fraudulent products	Loss of access	Malicious insertion	Quality and reliability
High Government Intervention	Government-proprietary	Other	●				
	Fine Disaggregation and Transience	TIC (IARPA)	●	●	○	○	
		VAPR	●				
	Functional Disaggregation	SPADE	●			●	●
		DAHI	●		○	●	
		CHIPS	○		○	●	●
	Obscuration and Marking	CRAFT			●		●
		eFuses	●			●	
		SHIELD	○	●			
	Verification and Validation	IRIS		●		●	●
High Commercial Sponsorship		TRUST		○		●	

VAPR will help protect intellectual property in DoD microelectronics.

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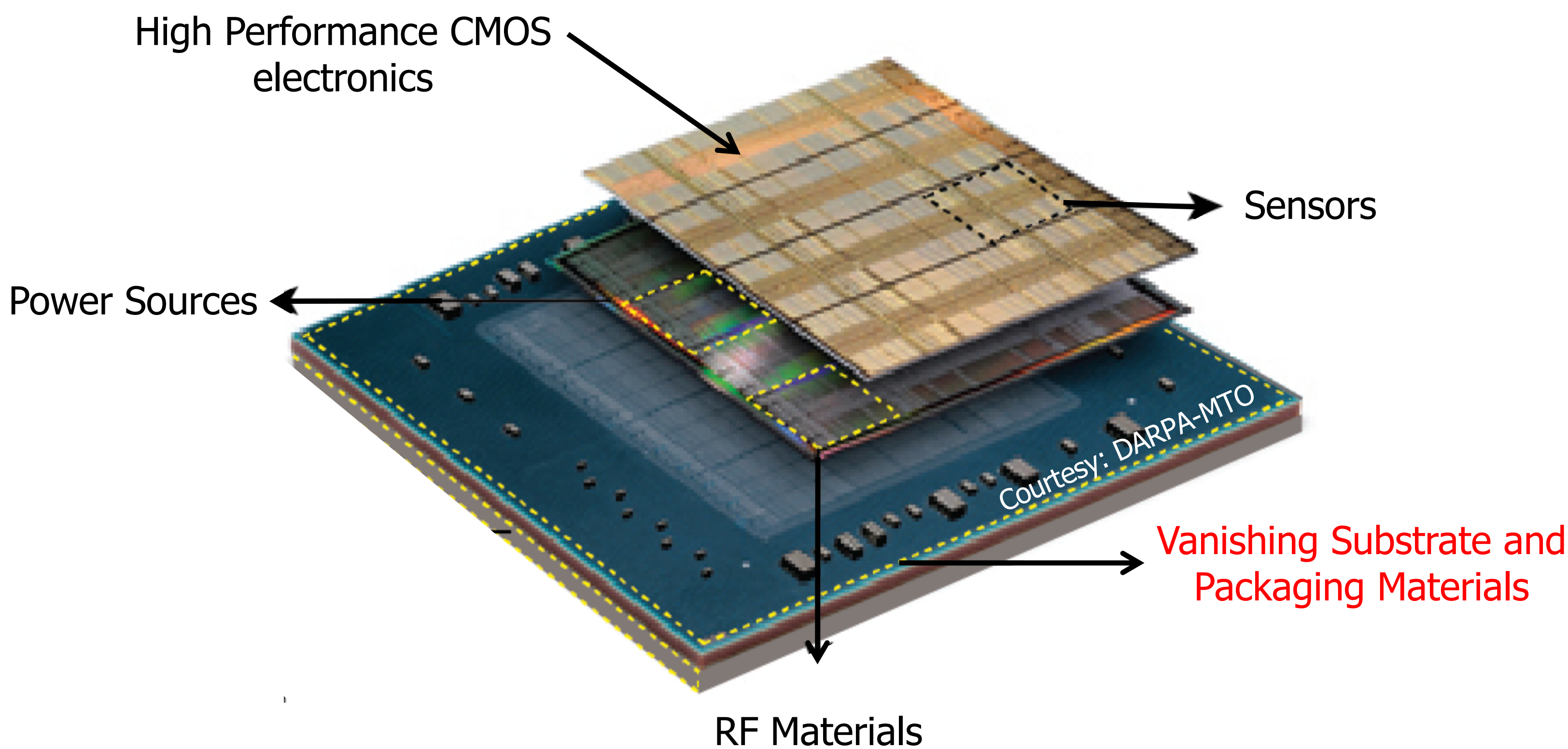
VAPR program objective

Develop a toolkit that allows for microelectronic systems to vanish in a controlled manner on command



High performance microsystems that physically disappear resulted from the program

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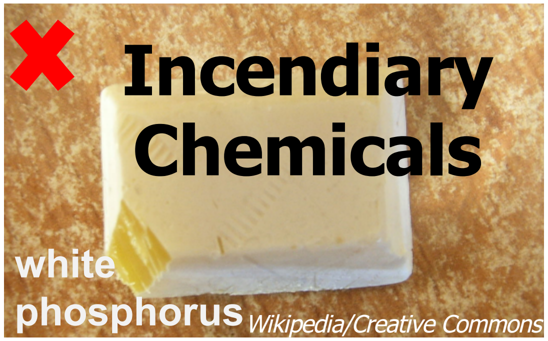
VAPR vanishing requirements

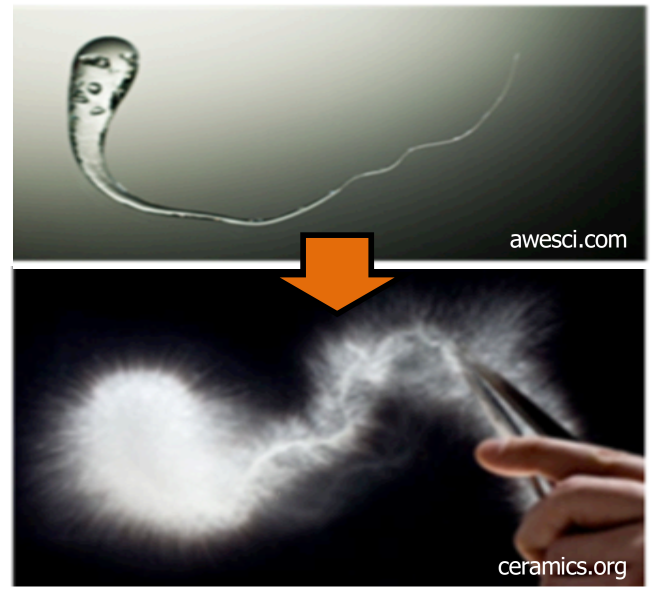
- Requirements were placed on the vanishing modality to ensure clandestine operations and environmental safety
- Camouflage was not considered vanishing



VAPR transient glass substrate

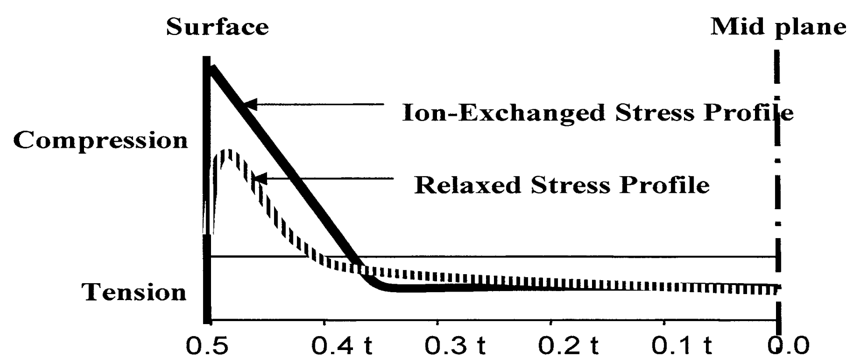
Prince Rupert's drop

- Formed by rapidly cooling molten glass
- Compressive stress on the surface and tensile stress at the core
- Stress gradient results in high toughness
- Surface damage results in rapid disintegration into fine particles



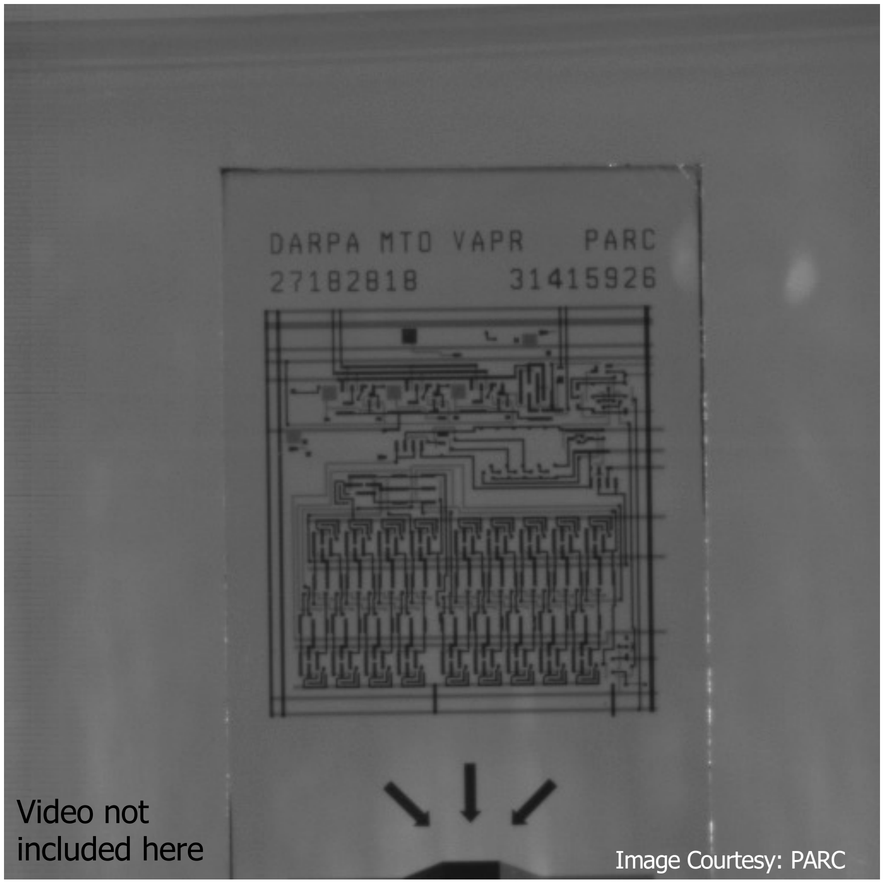
PARC's transient substrate

- Stress gradient formed by ion exchange of glass
- Similar to Gorilla Glass process
- Highly controlled stress profile

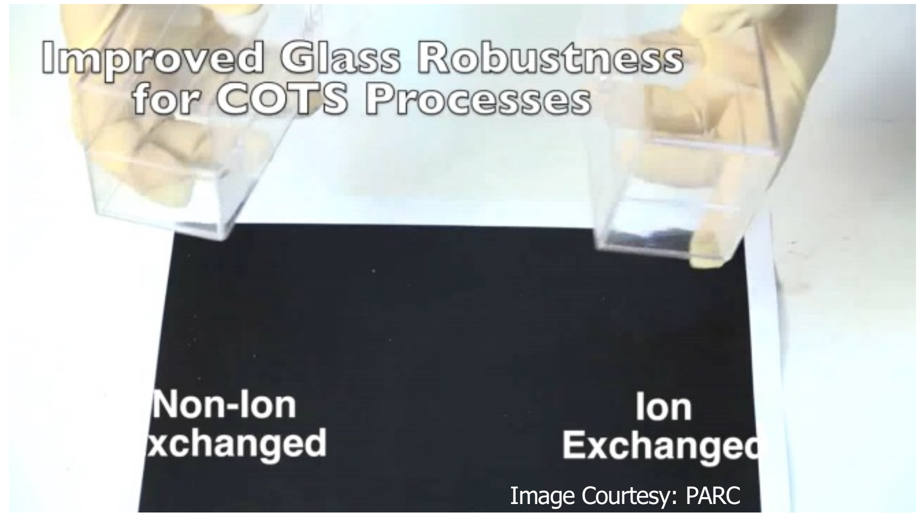


VAPR glass substrate demonstration

Demo: Trigger initiates rapid heating and cooling above resistor to initiate crack formation



Demo: Robustness during handling and storage



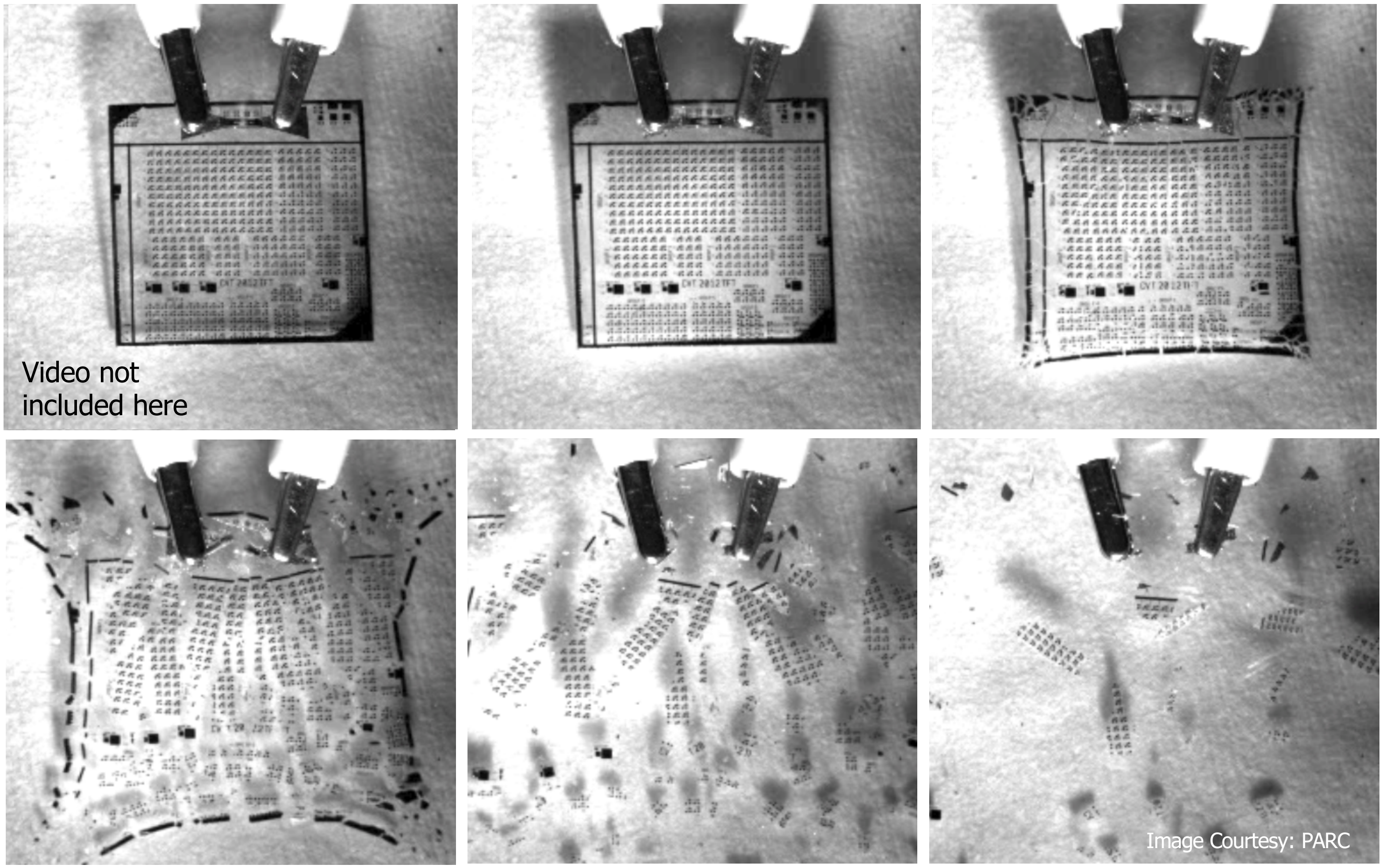
Video not included here

Extremely **Reliable and Stable** until Triggered to Vanish!

VAPR glass substrate fragmentation

Time Evolution of Fracture

0 ms | 0.13 ms | 0.20 ms



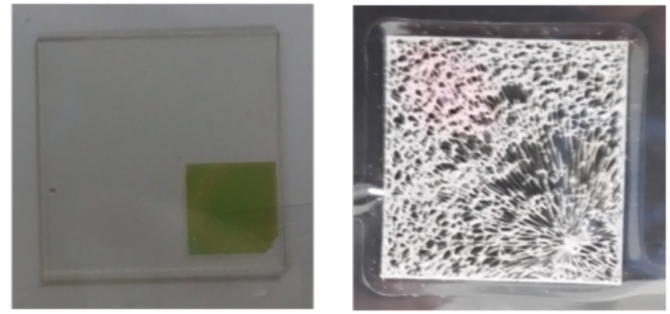
0.96 ms | 3.24 ms | 10.07 ms

(U) 0.25 mA hr, peak current of 1 A

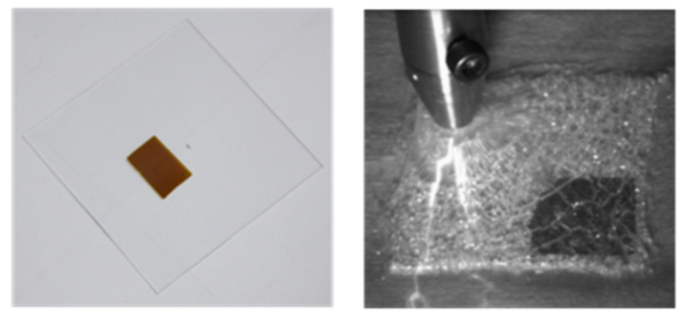
VAPR functional vanishing chips

- Enhanced security through vanishing electronics
- Strain energy transferred from PARC substrate to COTs chips
- Fragmentation of ICs and substrates to particle sizes < 250 μm
- Goal to achieve no visible remnants after triggering

silicon (transfer)



GaAs epilayer (transfer)



InP epilayer (transfer)

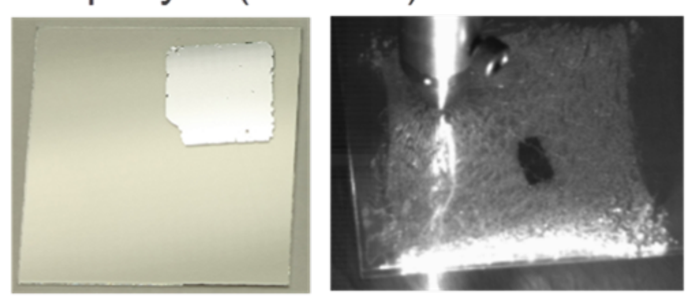


Image Courtesies: PARC

Summary

- DARPA VAPR Program has demonstrated a frangible glass substrate that can fracture into < 250 μm particle upon triggering
- Robust handling and storage of the frangible glass has been shown
- Fracture propagation through diverse set of chips has been demonstrated
- Functional devices have been produced that demonstrate use of COTS devices, these devices can monitor temperature and receive RF signals

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