# Impact of High-field Stress on Amorphized $Ge_2Sb_2Te_5$ Line Cells and Its Implications to Charge Trapping at Room Temperature

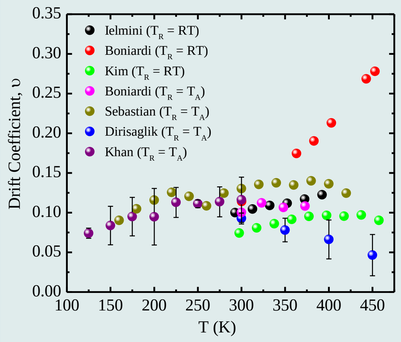
**A B M Hasan Talukder**, Md Tashfiq Bin Kashem, Raihan Sayeed Khan, Helena Silva, and Ali Gokirmak

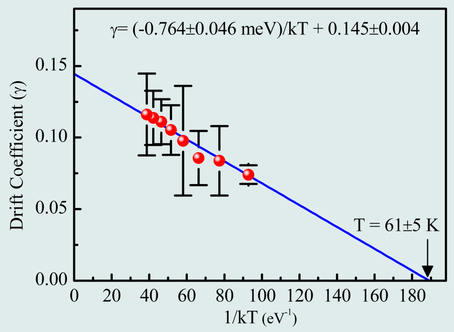
*Department of Electrical and Computer Engineering, University of Connecticut, Storrs, CT, USA*

*Email: talukder@uconn.edu*

## Motivation

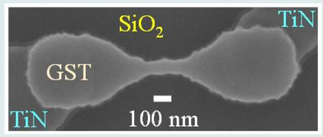
**Resistance Drift** $R = R_0\left(\frac{t}{t_0}\right)^{\upsilon}$ ***One of the biggest challenges!***



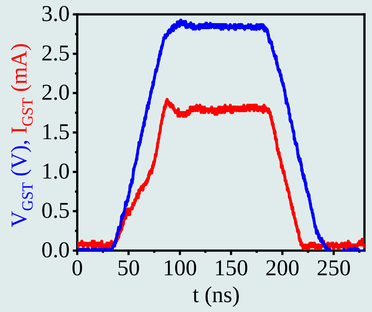

*Drift Acceleration and Stoppage at Cryogenic Temperatures*

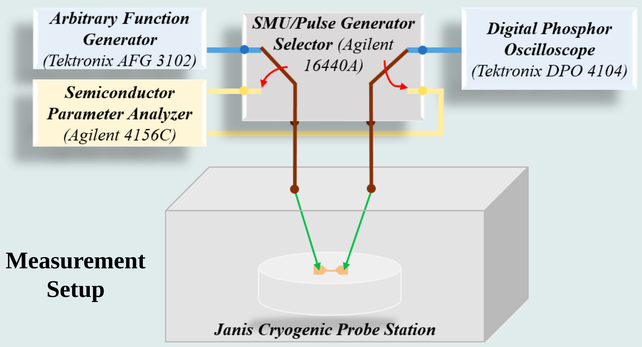
- *We observe a stronger response to electric field above ~21 MV/m, transitioning from a low-field response to a high-field response, and substantial acceleration in resistance drift at ~26 MV/m*
- *As current compliance is small, self-heating and thermally induced structural relaxation are not expected in the devices as a whole*



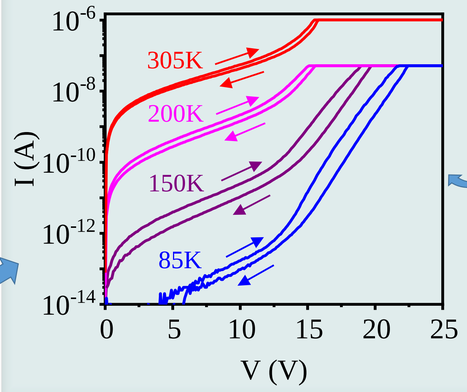

**SEM image of GST line cell**

*fabrication*



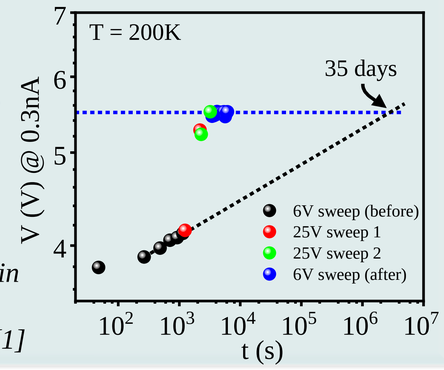




**Measurement Setup**




**Hysteresis observed during I-V sweeps immediately after amorphization**

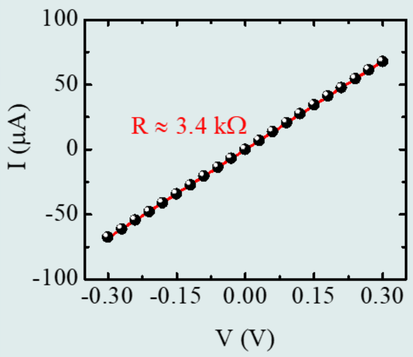
**Voltage required to reach 0.3nA vs time**



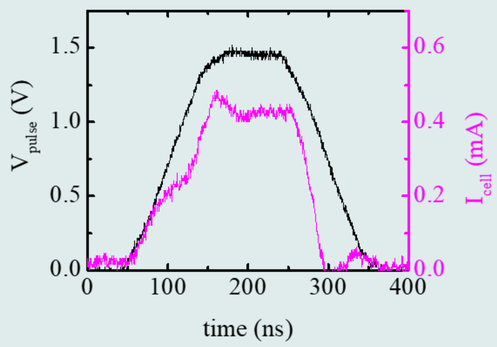

*Devices reach their final resistance value within minutes with high electric-field stress, which normally takes place in months without stress [1]*

## Measurement Flow

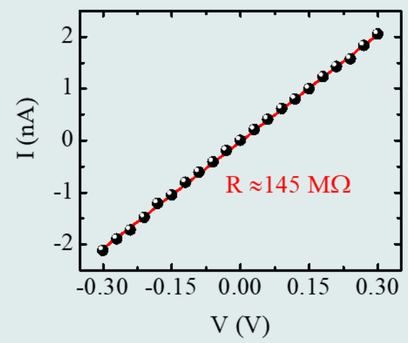
***Measuring the resistance of the cells with a low-field sweep***

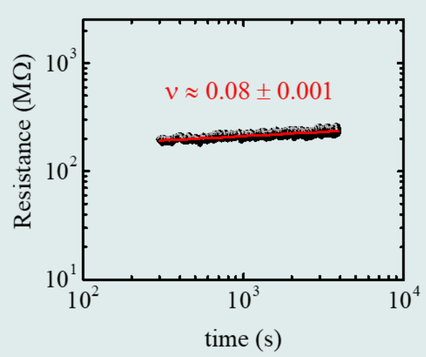



***Applying the amorphizing pulse of suitable amplitude and duration***

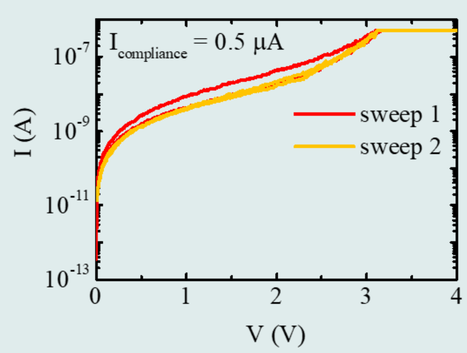



***Measuring the resistance of the cells to confirm the amorphization***

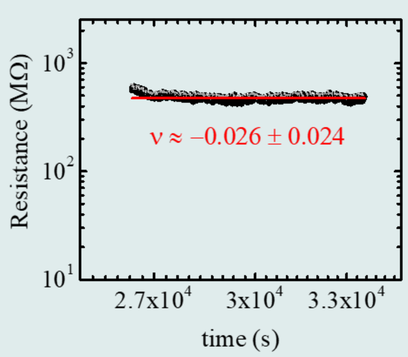


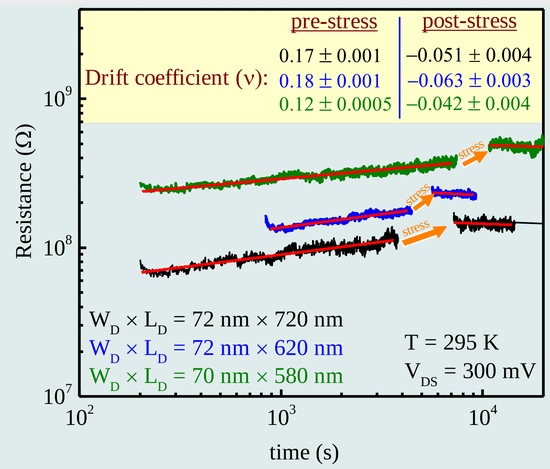

***Measuring the drift coefficient immediately after amorphization for an hour at a constant read voltage of 0.1 V***



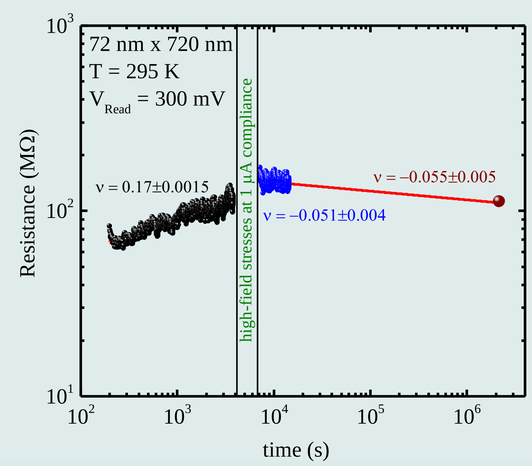

***High-field stresses (continuous sweeps from 0 to 4 V to 0 V in this case) for a duration in the order of minutes***




***Measuring the drift coefficient for an hour at a constant read voltage of 0.1 V after stressing the cells with high-field sweeps***




*Measured across several narrow width cells: high-field stresses accelerate and reduce the resistance drift coefficient significantly at room temperature*




*The drift coefficient measured right after stabilizing the device of designed W x L = 72 nm x 720 nm with high-field pulses at 295 K remains almost unaffected after ~25 days and the device resistance is approximately reduced to the pre-stress level after 25 days*

- *High-field stress induces changes on the percolation paths, device resistance increases and fluctuations in current decrease*
- *These changes may be due to relaxation of the charges left in the traps within a-GST as devices quench or annihilation of unstable trap sites that assist percolation transport [2]*
- *Both of these processes would lead to substantial distortion of the potential profiles and change the trapped-charge emission rates*

T = 80 K
$V_{DS}$ = 10 V

Pre-stress

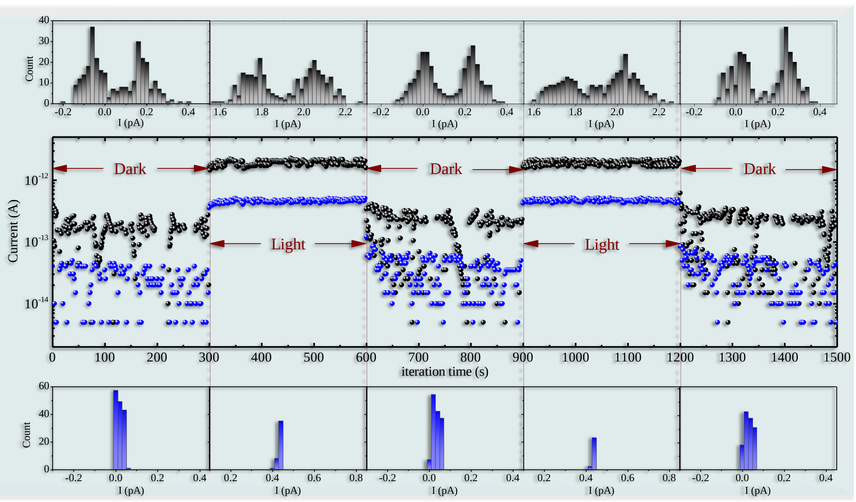
*Constant 10 V measurements for 1500 s right after amorphization*

*More fluctuations*

Post-stress

*Constant 10 V measurements for 1500 s after two high-field sweeps*

*Reduced fluctuations*




**References**

[1]R. S. Khan et al., Dev. Res. Conf. (DRC), 2020, pp. 1-2, doi: 10.1109/DRC50226.2020.9135147.

[2]R. S. Khan et al., Appl. Phys. Lett. 116, 2020, doi: 10.1063/1.5144606

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