Metastable Behavior in Admittance Spectroscopy – CZTSSe (PV-1)

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Scientific Achievement:

We clearly demonstrate the impact of a carrier-injection pretreatment on CZTSSe in admittance spectroscopy that has a large impact on the number of defect signatures and their corresponding activation energies.

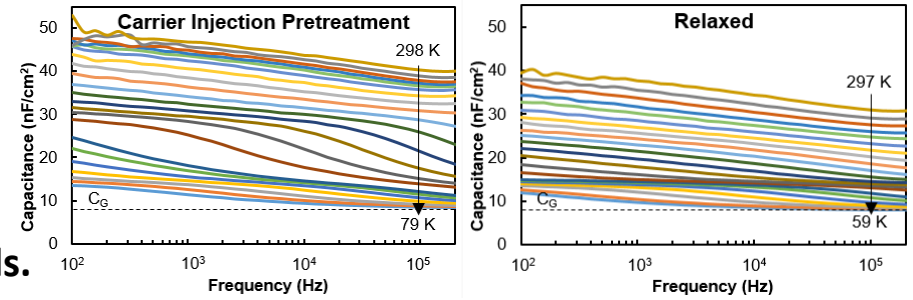
Significance and Impact:

Admittance spectroscopy is a tool used by many researchers to probe defects in semiconductor materials. Although metastable behavior has been observed in CZTSSe in IV(T) and EQE measurements, here we demonstrate how metastability impacts admittance spectroscopy results. We propose a carrier-injection pretreatment be completed at each temperature step prior to the measurement to ensure that the device is in a similar state for each measurement.

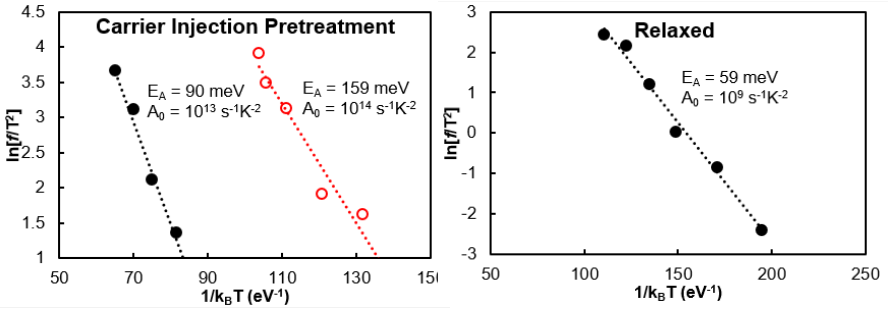
Research Details:

Using an 8.1% CZTSSe device fabricated from nanocrystal ink, admittance spectroscopy was completed and analyzed in a relaxed condition and a carrier-injection pretreatment condition:

- For the relaxed condition, the cell was kept in the dark at low temperatures for several hours. This analysis shows one defect signature with a 59-meV activation energy.
- For the pretreatment condition, the cell was exposed to a +0.2 V_{DC} forward bias for 5 minutes at each temperature prior to the 0 V_{DC} measurement. The analysis shows two defect signatures with 90-meV and 159-meV activation energies.



Capacitance vs. frequency at multiple temperatures for a CZTSSe device with a carrier-injection pretreatment (left) and relaxed without any pretreatment (right).



Arrhenius plots extracted from the capacitance data above. The carrier-injection pretreatment results in two defect signatures (left), whereas the relaxed condition only has one defect signature (right).

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