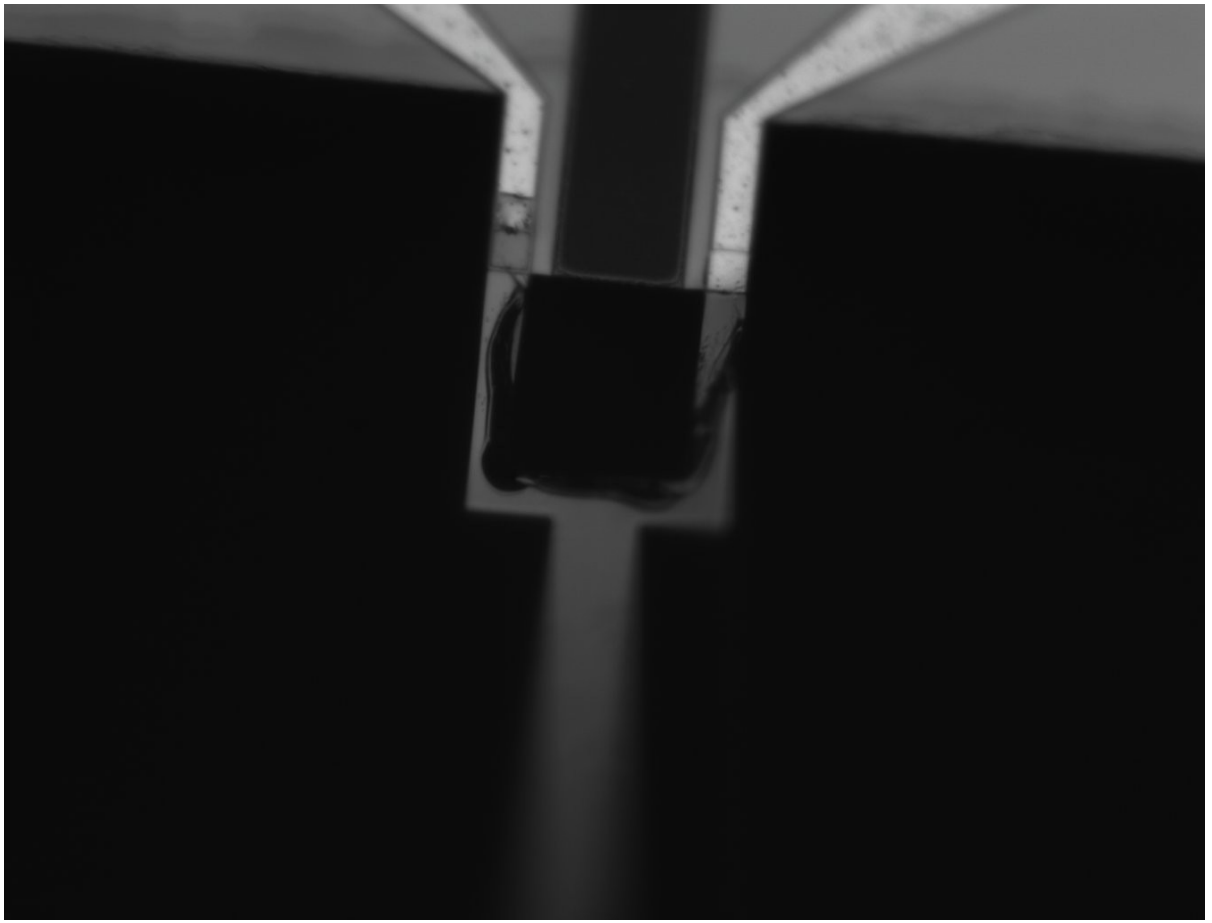


A vaporized PR/PE cantilever

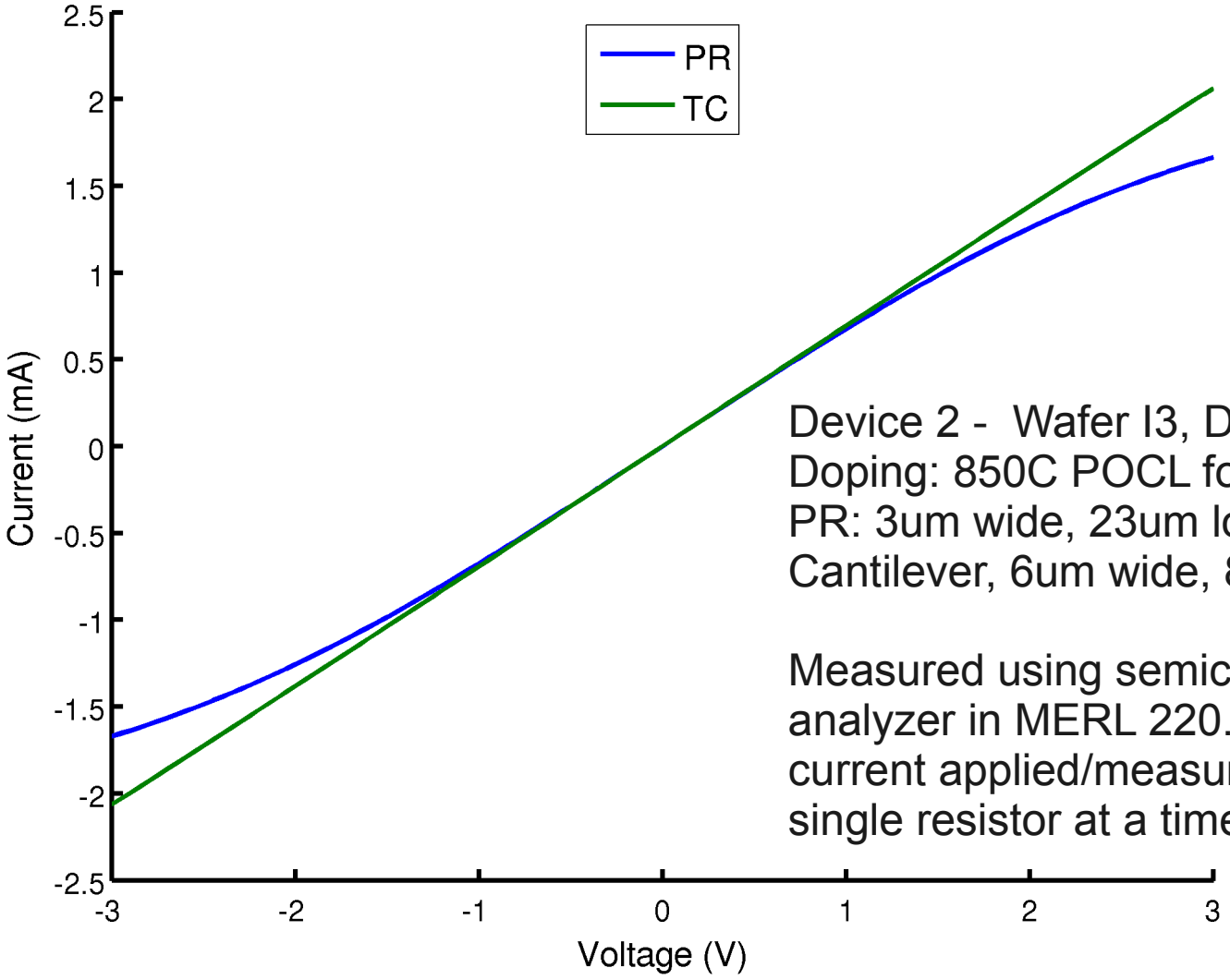
Some I-V and Noise Measurements

Joey Doll
Dec. 22, 2009

Overview

- Have been measuring I-V curves and noise of my 340nm thick PR devices
- I haven't seen this in all of my measurements, need to figure out what has changed
- Strong thermal effects are seen in both I-V and noise characteristics
- Just wanted to share the curves and plan on doing more measurements eventually

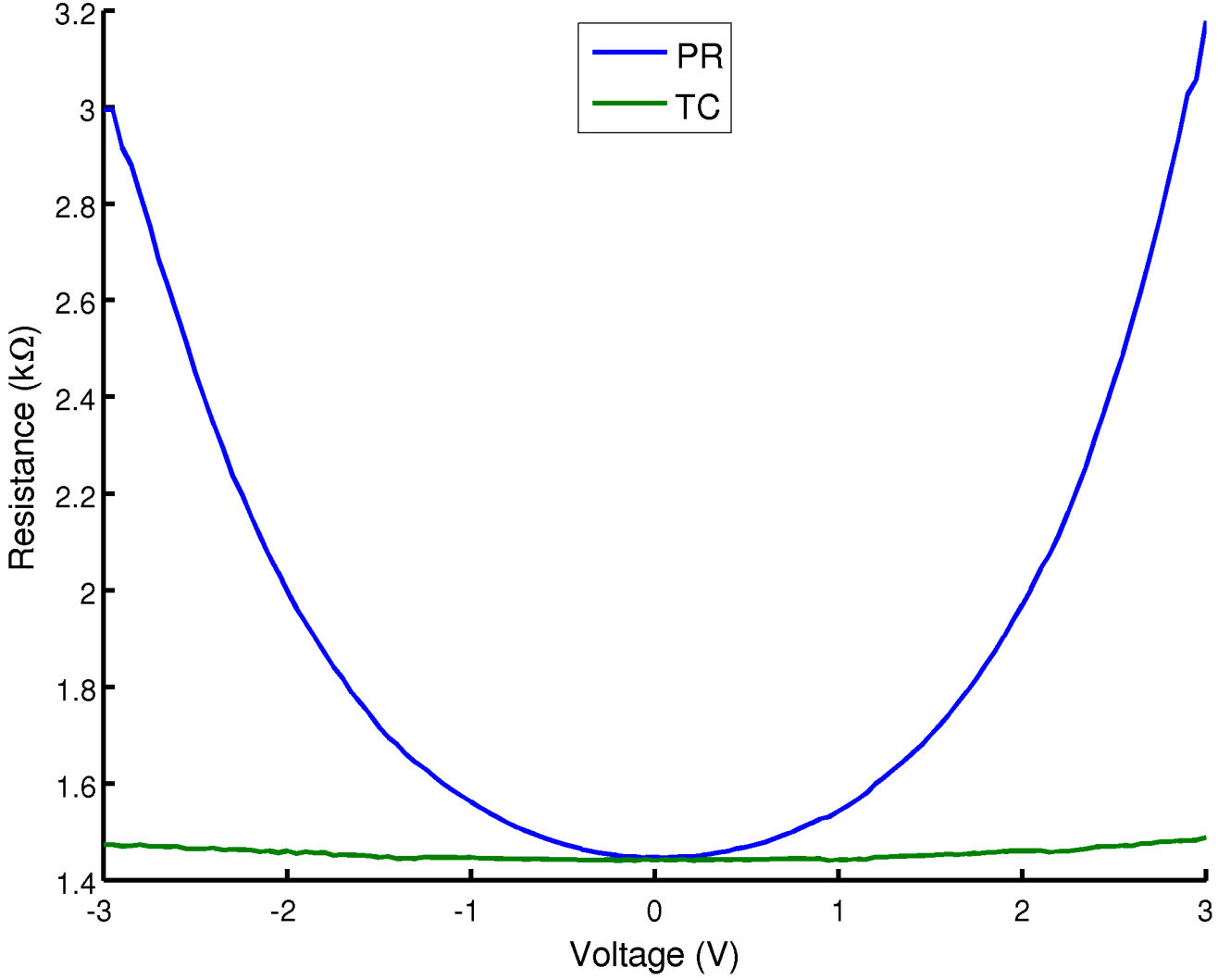
Typical I-V Curve



Device 2 - Wafer I3, Design #4
Doping: 850C POCL for 15 minutes
PR: 3um wide, 23um long
Cantilever, 6um wide, 87um wide

Measured using semiconductor analyzer in MERL 220. Bias and current applied/measured across a single resistor at a time.

Typical R Calculation

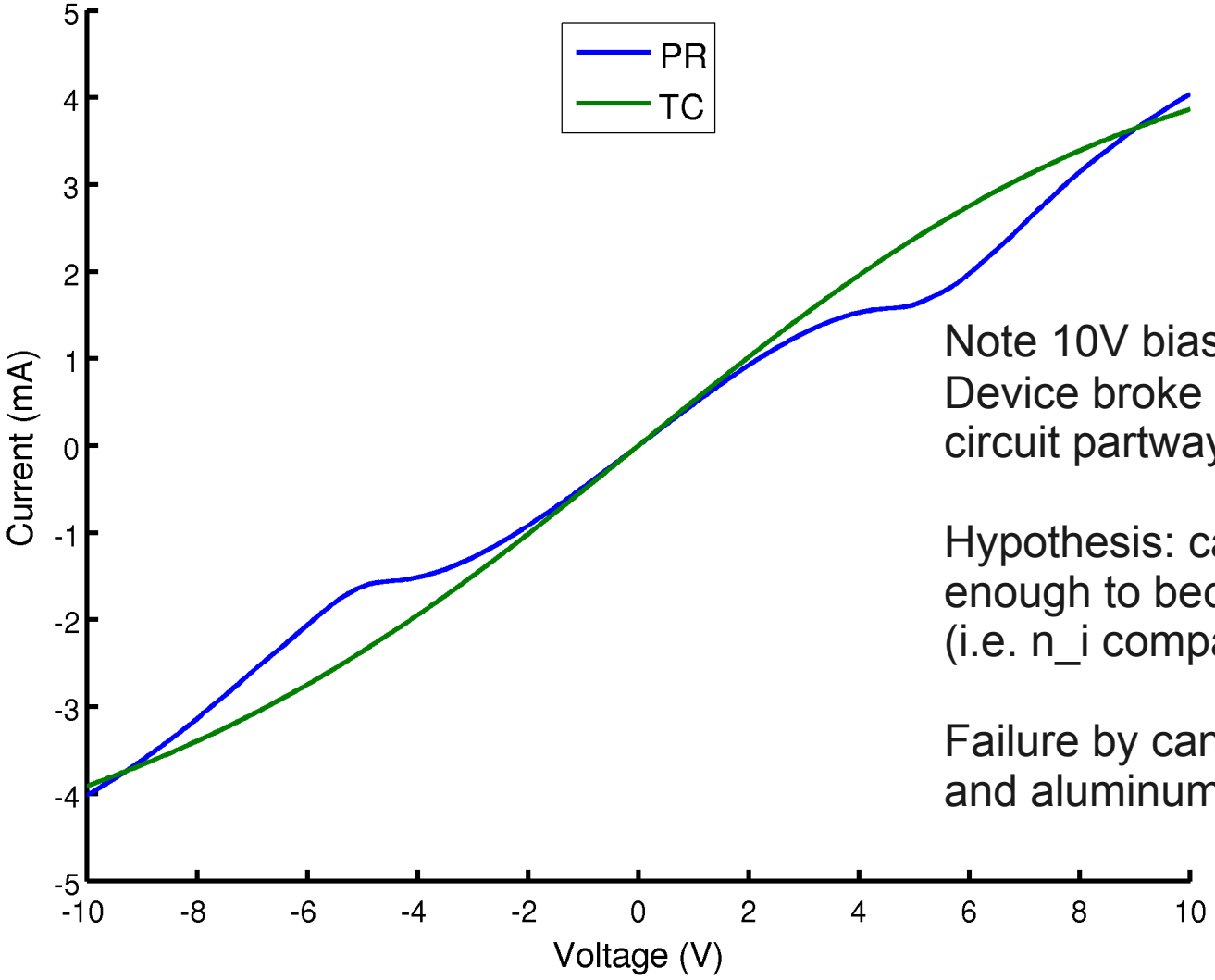


Resistance increase with voltage because mobility decreases with temperature

Temperature could be inferred from resistance (with calibration)

Cantilever reaches steady-state temperature faster than the analyzer steps from one voltage to another (same results whether V is swept or held at each voltage)

Thermal Breakdown

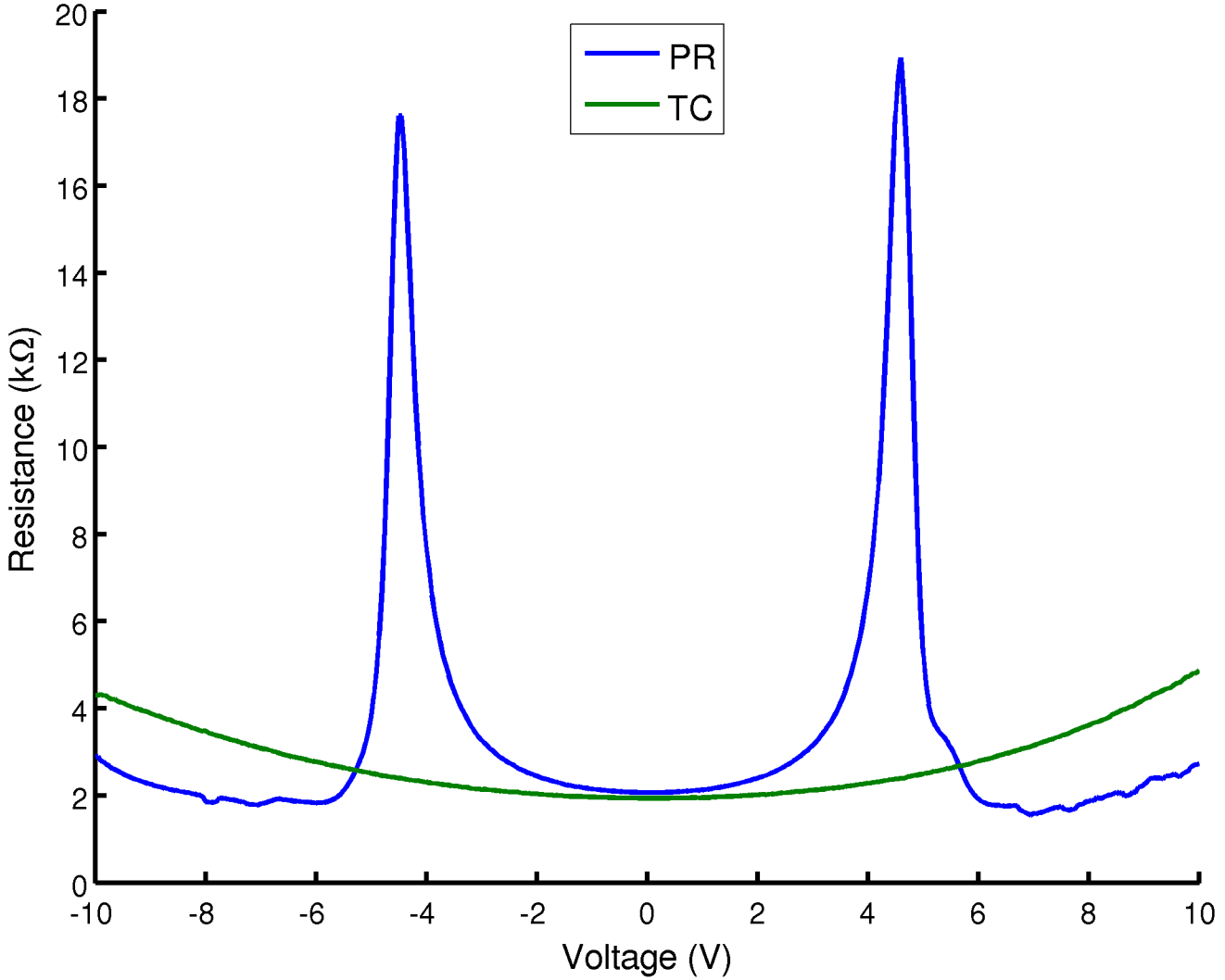


Note 10V bias (20V bridge)
Device broke on the 3rd repeat (open circuit partway through I-V)

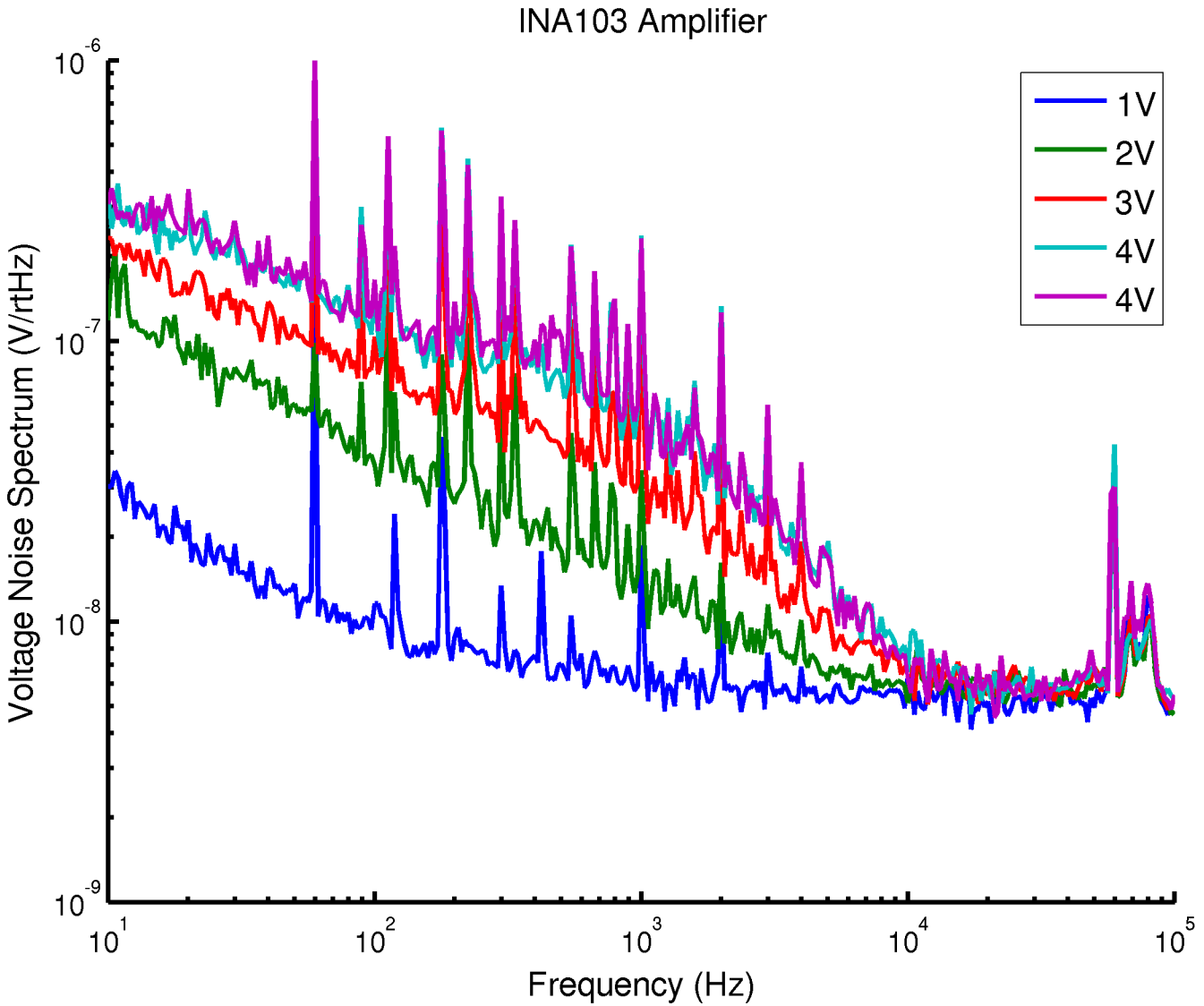
Hypothesis: cantilever gets hot enough to become intrinsic again (i.e. n_i comparable to N_d ~ 1e20)

Failure by cantilever cracking/vaporizing and aluminum vaporizing. 10V → 60 mW

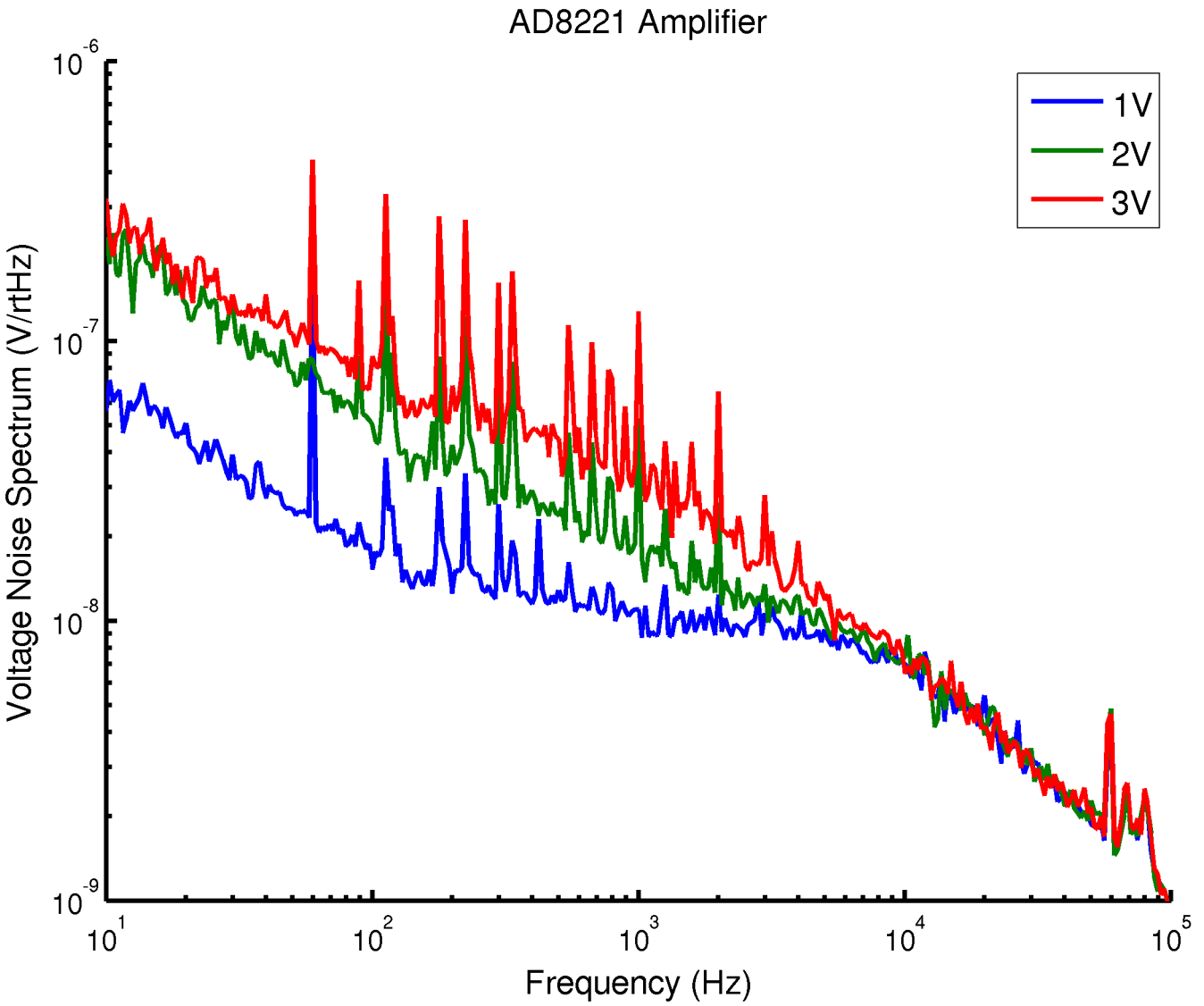
Thermal Breakdown



Noise w/ INA103, DC bias, 1000x gain



Noise w/ AD8221, DC bias, 1000x gain



Conclusions

- The resistance of the PR located on the cantilever deviates significantly from the TC resistor.
- Increased noise for small devices at large bias voltages.
- 1/f^n-esque near 10kHz but flattens out to 1/f at around 10 Hz. The noise is more of a lump than a trend in the data.
- Might not be an issue for my measurements (broadband high freq). Haven't compared the impact on resolution, i.e. integrated excess noise. Might be reduced in liquid. Still interesting.
- Things to look into eventually
  - Measure LDV spectrum vs. bias voltage (is the motion always there and just amplified by the larger bias)
  - Measure noise in vacuum (is fluid movement required)
  - Measure noise at elevated and reduced temperatures (reduce/increase temperature difference between the cantilever and ambient)