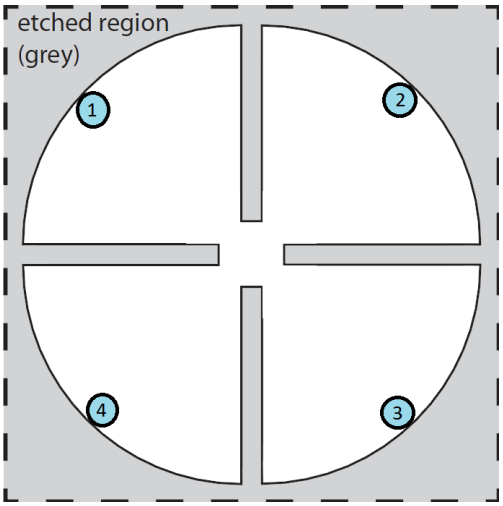
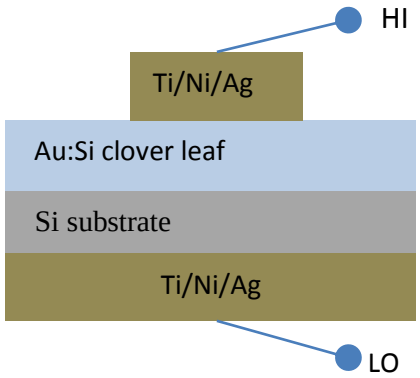
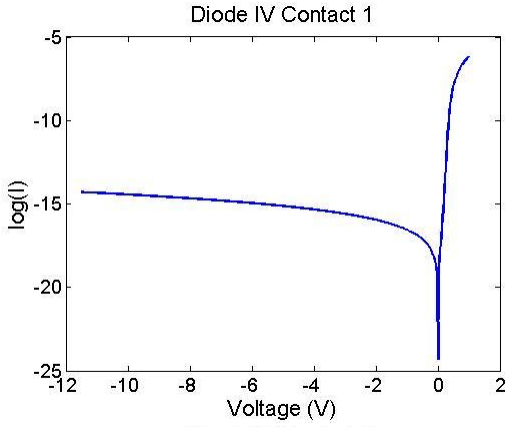
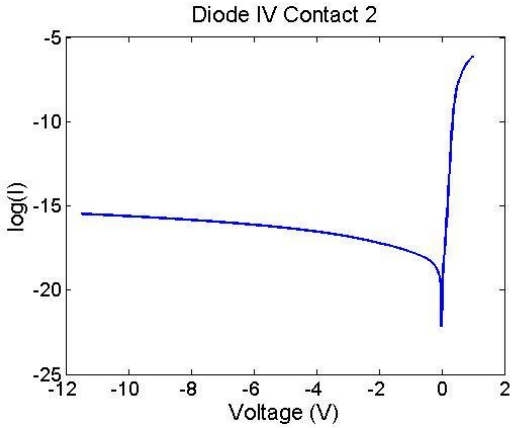
Contact Configuration

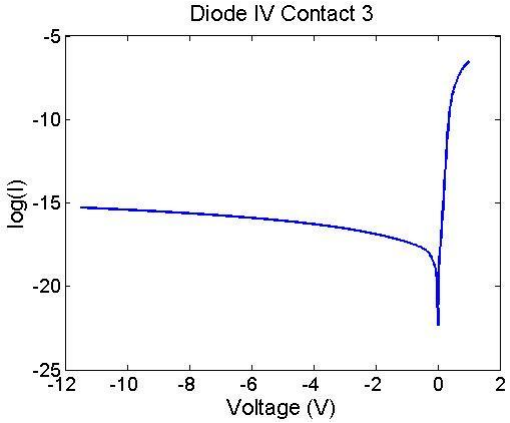


The substrate is <100> n-type Si with 1-10 ohm-cm resistivity. The contact on the bottom of the substrate is connected to the LO terminal for diode test. The Au:Si layer on the top of the silicon substrate is found to be p-type. When the IV measurement on the diode is performed under normal condition, -100nA < I(0) < 0. When the measurement is performed in the dark, I(0) is very close to 0. Depending on the contact used, slightly different IV curve for the diode is experimentally measured. Dark IV of the diode:

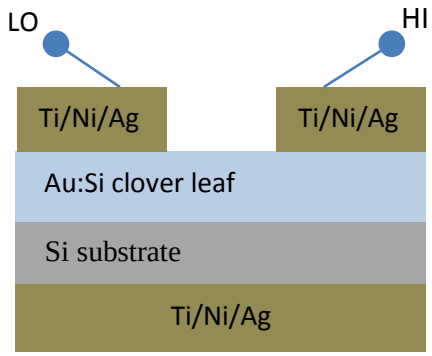


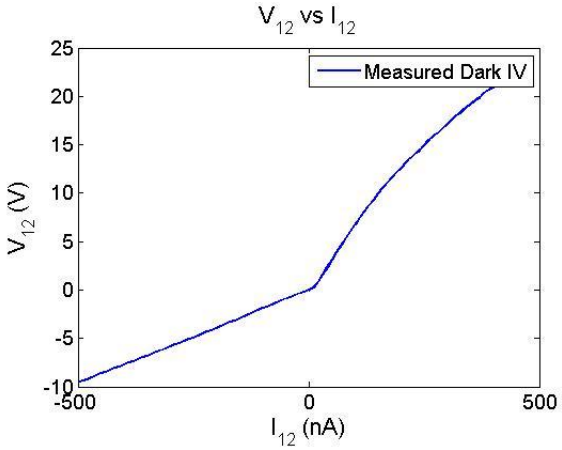


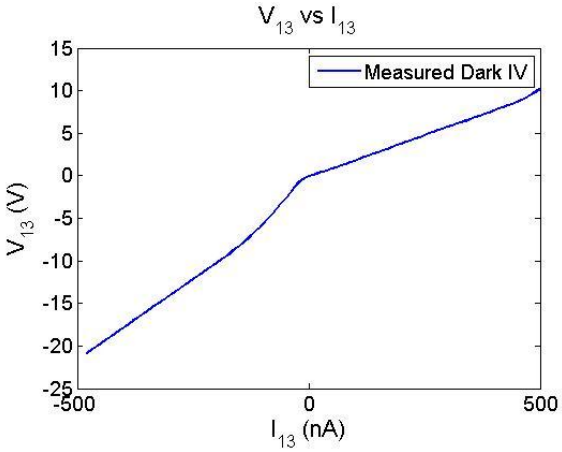


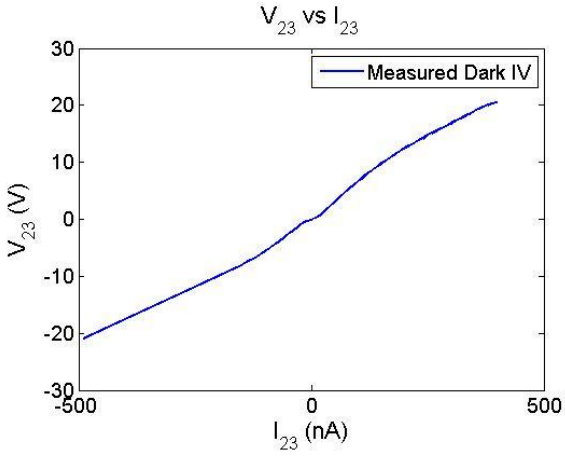


IV measurement across top contacts is then performed. Nonlinear behavior is observed even though the junction rectifies. Positive and negative voltage sweep yields different IV slope as well.

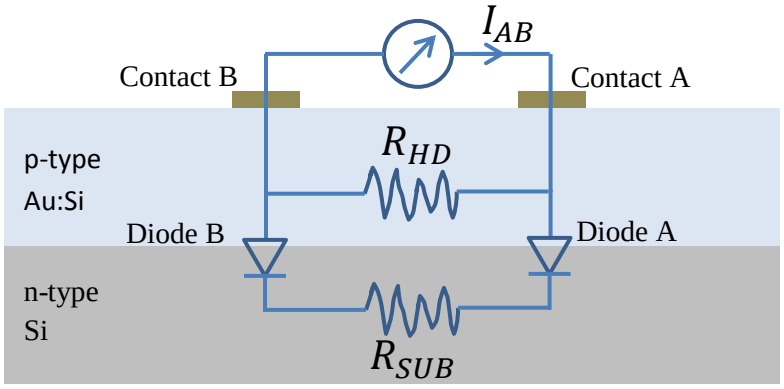








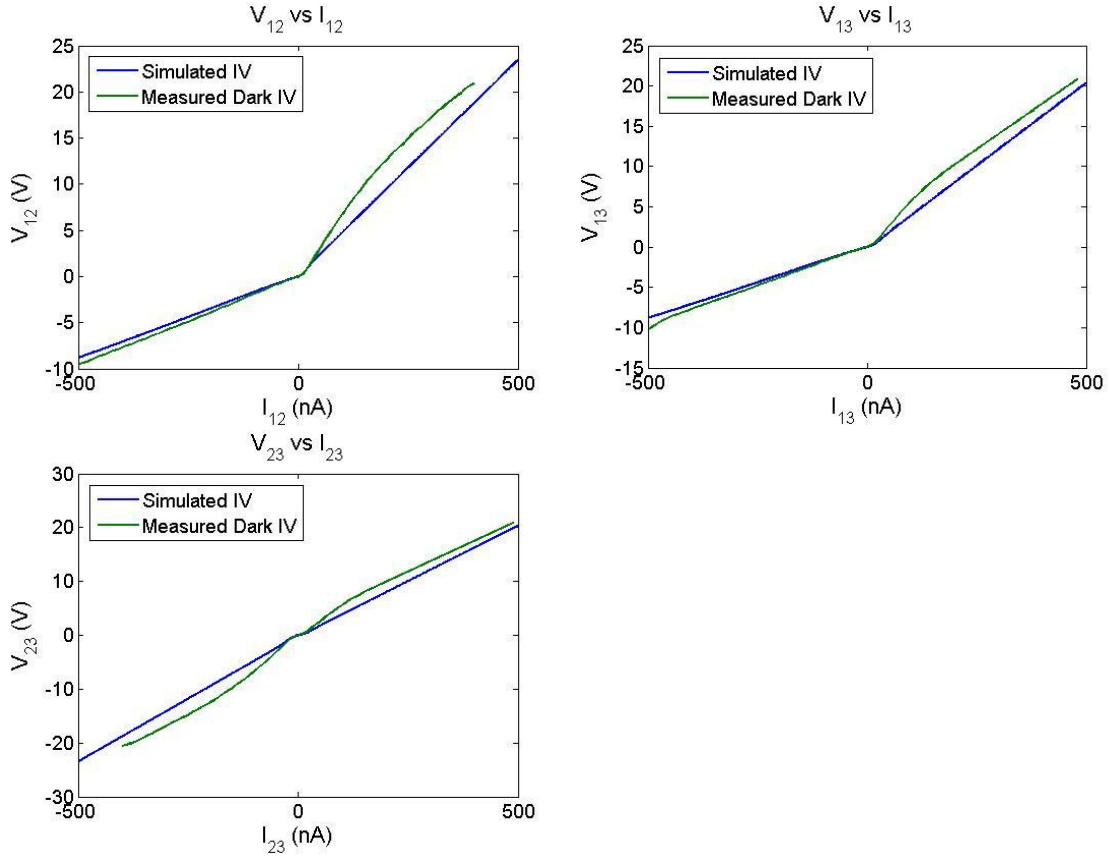
To explain this result, an equivalent circuit is modeled:



$$R_{SUB} \approx \frac{10\ \Omega \cdot cm \times 1\ mm}{0.1\ mm \times 0.5\ mm} = 2000\ \Omega$$

$$R_{HD} \approx 200\ M\Omega\ (temporary\ estimate)$$

After inputting the raw dark IV data for each diode directly into the model, we simulated the output IV curve of the system. Extrapolation of the dark diode data is used when the reverse bias across the diode is larger than 11.5V. The result is then compared with experimentally measured dark IV curve across different contacts.



From the calculated values, it is found that the R_{HD} greatly surpasses $R_{SUB} + R_{DIODE}$. Because of this, the current mostly flows through the substrate instead of through the hyperdoped region. At this point, changing the value of R_{HD} only changes the IV curve slightly.

If we try to estimate the diode resistance in the reverse bias, it is in the order of 10^7-10^8 Ω. In order to accurately obtain the linear IV curve which characterizes the hyperdoped layer resistance, either of the following is needed:

1. $R_{HD} < 1\ M\Omega$
2. $R_{SUB} > 10^{10}\Omega$
3. Au:Si diode with larger resistance in the reverse bias, preferably in the 10^8-10^9 Ω range. In combination with the substrate resistance, this has to be much larger than R_{HD}.