Hafnium Contacts for n-type Conducting Nanocrystalline Diamond
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Research question
Previous work at ASU has shown Ti/Pt/Au to be an effective metallization for creating ohmic contacts on nanocarbon (nanoC). However, Hafnium has a lower work function than Titanium by 0.43eV and both metals have similar enthalpies of formation for forming carbidies. This implies the ability to form strongly adhering carbidies at the interface while lowering barrier height and contact resistivity compared to Ti.

Hf Evaporation Process Development
Left: Crucible with Hf pellets before slug melt. Right: Hf witness sample deposited on bare Si

Metal Patterning Overview
1: Acid Piranha Clean 2: Spin Photoresist 3: Expose Pattern
4: 50nm Hf / 50nm Pt / 200 nm gold 5: Deposit Metal 6: Strip Resist

Nanocarbon Characterization

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample 22-048</th>
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</thead>
<tbody>
<tr>
<td>Bulk electron concentration (cm$^{-2}$)</td>
<td>$1.69 \times 10^{10}$</td>
</tr>
<tr>
<td>Sheet electron concentration (cm$^{-2}$)</td>
<td>$5.08 \times 10^{10}$</td>
</tr>
<tr>
<td>Sheet resistance (Ω·cm$^{-1}$)</td>
<td>478</td>
</tr>
<tr>
<td>Resistivity (Ω·cm)</td>
<td>$1.43 \times 10^{-2}$</td>
</tr>
<tr>
<td>Mobility (cm$^{-2}$·V$^{-1}$·s$^{-1}$)</td>
<td>2.37</td>
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</tbody>
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Nanocarbon Characterization 5mm x 5mm patterned NanoC sample

Contact Evaluation
Optical microscope image of circular transfer length method (cTLM) structures.

Conclusions & Future Work:
- Contacts show ohmic behavior but are inconsistent. Contact resistivity cannot be extracted by fitting to cTLM equation.
- Future work is needed to study how thermal processing can control the interface and improve reliability of contacts.

Acknowledgements:
Evangeline Amoroo for initiating the project, Eugene Hsu and Mihirat Fanzu Manahile for providing the photolithography process used in the project, Professor Trevor Thornton for allowing me to use his probe station, Professor Robert Nemirich and his students for growing and providing the nanocarbon sample, and the staff of ASU Nanofab for training me on the equipment used to conduct the project.

Process flow for depositing contacts by bi-layer lift-off process. An additional step performing a thermal anneal at 800°C in N$_2$ for 30 minutes is not shown.