Optimization of Hexagonal Boron Nitride Synthesis

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Abstract: Graphene, a two-dimensional (2D) material, has been discussed as the next-generation electronics rather than silicon. Due to graphene’s high conductivity, graphene is required to be interfaced with other 2D materials to truly enable 2D nanodevices. Boron nitride (BN), a 2D insulator, has been identified as a promising substrate that improves graphene-based devices. Although BN has been successfully synthesized by chemical vapor deposition (CVD), the mechanism of boron nitride synthesis can still be optimized. This study investigates the role of hydrogen in synthesis hexagonal boron nitride (hBN). Scanning electron microscope (SEM) is used to characterize the samples and full coverage of hBN is observed on all samples with different sizes of multilayer hBN.

Background

Boron nitride has many attractive properties: 1: 2D insulator 2: Atomic flatness 3: High electrical resistivity 4: Large optical gap 5: Large thermal conductivity

Motivation

Graphene devices are traditionally built on standard silicon dioxide substrates but the combination sets many limits on the intrinsic properties of graphene. Hexagonal boron nitride (hBN), a two-dimensional insulating material, has been identified as a better alternative that improves graphene-based devices. To have a natural complementary dielectric layer, graphene can be stacked using hBN similar to how silicon has silicon dioxide.

Chemical Vapor Deposition (CVD)

main stream of reaction gases

1) diffusion of precursors 2) adsorption on the surface 3) chemical reaction 4) desorption of adsorbed material 5) diffusion of byproducts

Results and Analysis

Gas flow ▶

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>20 scc/m H₂</th>
<th>50 scc/m H₂</th>
<th>100 scc/m H₂</th>
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<tbody>
<tr>
<td>15 mins</td>
<td>0.25µm²</td>
<td>0.29µm²</td>
<td></td>
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<tr>
<td>30 mins</td>
<td>0.42µm²</td>
<td>0.65µm²</td>
<td></td>
</tr>
<tr>
<td>60 mins</td>
<td>0.53µm²</td>
<td>0.98µm²</td>
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Future Steps

• Investigate the role of cooling rate in synthesis of boron nitride.
• Program precursor temperature controller to prevent itself from overheating.

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References


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