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Effect of Solvent Induced Dipole in ALD of Al_2O_3 on HOPG

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The motivation of this project was that graphite was found to be a very interesting 2D material, but its inert surfaces do not let it chemically react well due to its hydrophobic nature which mostly causes reactivity only on the step edges. Devices made from graphene have many issues. One of these issues is that dielectric deposition techniques tend to cause damage to graphene's surface. An ideal technique would react with graphene without damaging its properties and deposit uniformly across the graphene surface. Previous studies have shown that TMA-O_3 shows better Atomic Layer Deposition (ALD) coverage than TMA-H_2O because of the high chemical reactivity of ozone in comparison to water. This reactivity causes the HOPG to be more hydrophilic which is more favored when performing ALD (B.Lee et al.,Appl.Phys. Lett.92,203102 (2008).) In this work we attempt to study the effect of a large variety of solvent treatments with different dipole moments on HOPG's surface and the solvents corresponding role in ALD coverage.

We began by soaking freshly cleaved HOPG (Highly Ordered Pyrolytic Graphite) in the solvents for 2 hours. The non-polar solvents included Hexane, Toluene, and

Chloroform. For the polar-aprotic solvents we used Acetone, DMSO, and Propylene Carbonate. Lastly, for the polar-protic solvents we used H_2O, and Acetic Acid. After they were soaked we performed Atomic Layer Deposition of Al_2O_3 on the treated HOPG. Lastly, an Atomic Force Microscope was used to see the amount of coverage on the HOPG. The results showed that polar-aprotic solvents (high dipole moments) and non-polar solvents (low dipole moments) did not have much uniform coverage. However, the polar protic solvents (around the dipole moment of water) showed much better, uniform coverage. After we tested the HOPG for uniformity, we exfoliated the HOPG again and tested the contact angle on the surface of the graphite. The results showed that the contact angles did not show any form of pattern depending on the dipole.

We concluded that since higher dipole moments do not lead to more uniform coverage, differences in dipole moments are not the reason why ALD on HOPG works better with some solvents as opposed to others. Our next thought was that maybe the reason why the polar protic solvents had better coverage may have dealt with the larger regions of O-H densities. These O-H densities could possibly react with each other or the dangling bonds on graphene.