Current Progress in Superconducting Device Fabrication

CNF Project Number: 2998-22
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Primary CNF Tools Used: Heidelberg Mask Writer - DWL2000, ABM Contact Aligner, AJA Sputterer, AJA Ion Mill, Glen 1000

Abstract:

The Fatemi Lab is mainly interested in the intersection of low dimensional materials and quantum circuits. The current ongoing project is transport and microwave spectroscopy on graphene Josephson junction, and the main cleanroom activities are fabrication and packaging of those superconducting Josephson devices. So far, our efforts have been towards the deposition and measurement of base-layer superconducting niobium films.

Summary of Research:

The users from our lab have completed the cleanroom orientation and obtained the access in March this year. Later, Luojia got trained and started using the AFM to measure the thickness of boron nitride for our 2D materials stack. The majority of the fab work started in this summer. Haoran was trained on the wire bonder and used it to package preliminary resonator devices.Luojia started making devices with sputter deposition, photolithography, and RIE etching. The first contact mask was made using the Heidelberg DWL2000 mask writer. Later, the AJA sputterer was used to deposit a layer of niobium on top of a silicon wafer. The sputtered wafer was then patterned using photolithography. For that, we used the ABM contact aligner with AZ nLoF photoresist. After determining the optimal spin coating recipe and dose, we used the AJA ion mill to etch away the metal, and Glen 1000 to descum the wafer.

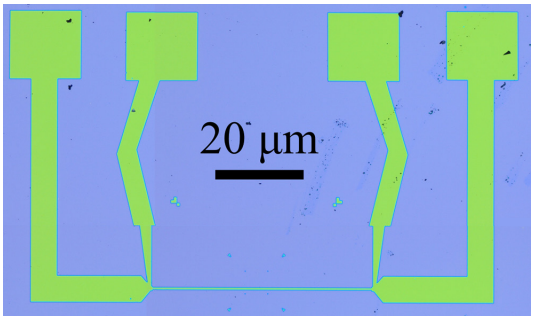

Figure 1: Image of etched niobium film patterned into a four-probe device structure for testing residual resistance ratio and the superconducting critical temperature.

Conclusions and Future Steps:

So far, we have made good first steps towards super-conducting niobium layers for use in Josephson and other superconducting devices. Next steps include:

(1) Determining the sputtering recipe to produce good quality nNB film with critical temperature larger than 9K.

(2) Print and use a stepper reticle for microwave resonators.

(3) Use E-beam lithography to make superconducting contacts with hBN-graphene-hBN stacks.

(4) Perform RIE side contacts on the 2D materials van der Waal stack, test the quality of the superconducting contacts.