Research and Exploration in Transistors and Data Acquisition Technologies

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SHINE Summer High School Intensive in Next-Generation Engineering

Introduction

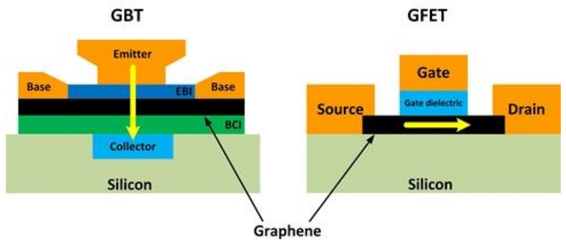
Here in Professor Wang's lab at USC he is conducting research on 2D materials and their applications in transistors. I did my research on a dielectric material called graphene and how it impacts transistors as well as on how we can go about measuring current through those transistors. I spent most of my time learning about the research that is being done here and on a few projects which all connect in the sense that they all involved transistors, which are the basic make-up of computer chips (i.e. CPU) and are responsible for transferring data in your computer.

Objective & Impact of Professor's Research

Computer chips have billions of transistors on them nowadays. So now Professor Wang's research focuses on replacing the dielectric that is currently used (Silicon) in transistors with a more conductive dielectric (monolayer graphene) which could potentially lead to smaller, more energy efficient computers and other technological devices. In order to help with the research that was already being conducted here in Professor Wang's lab I've tackled a couple projects but ultimately I first learned about transistors and how they're made. Then I learned about how to measure current in simple circuits with Ohm's Law and construct an IV curve for resistors in simple circuits using National Instruments hardware and software. Finally I've been tasked with using that hardware with a modified computer program (that uses the G programming language) to make a similar device that produces the same IV curve when measuring current in a transistor with given resistance.

Skills Learned

Throughout the process of creating a transistor and then throughout the process of measuring the current of that transistor, there have been several key skills and pieces of knowledge that I've picked up. Starting with the creation of that transistor, we first needed to learn about exfoliating graphene with tape. Then we focused on actually finding said graphene samples and extracting them after PMMA and IPA treatment. The next stage was focused on e-beam "sketching" and metal disposition. Now we are beginning the process of planting our electrode, finalizing the transistor, and then using that finalized transistor to help develop a software and utilize hardware in such a way that would allow us to measure the current that passes through that transistor and present some tangible results in an IV curve (a graph of voltage inputs and current outputs). The research going on in this lab is exploring graphene as a potentially better dielectric, but if a better dielectric (or solution) is out there, that is likely where research in this field will go in the future because the end goal is to optimize size, productivity, and efficiency in transistors.



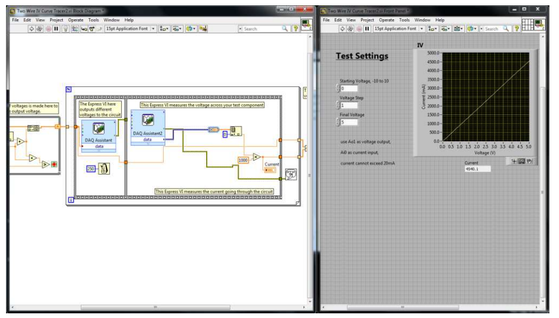
Two different methods of transferring current (data) via transistor

Other Skills Learned:

- C, G, and Matlab programming languages.
- Soldering for simple circuits.
- Simple understanding of transistors: how they work, what they do, and how they're made.

How This Relates to Your STEM Coursework

The SHINE program here at USC has given me plenty of insight as to how what I learn in my STEM coursework is actually applied in the real world. It's given me an understanding and a respect for the research that goes on here, and it has taught me how to conduct my own research via USC online databases and how to properly format potential research papers. It's taught me to better understand and summarize scientific research, and it's given me ideas for where I'd like to continue my studies in the future and where I'd like to apply myself in the job world after I finish school. However, more specifically, this research has related to my STEM coursework by demonstrating some applications of "Physics C: Electricity and Magnetism," a class I took last year, which whilst being very challenging also gave me the basic understanding of things like simple circuitry, which I needed to finish this program. Hopefully I'll be able to bring back some inspiration and ideas to inspire other students at my school to consider electrical engineering as a potential field of study and some interesting ideas for discussion with my peers in my school's robotics team because of the knowledge I gained here in my research and exploration of CS and EE.



Computer code (in G) to compute currents for given voltage values with a constant resistivity that also displays an IV curve for a standard resistor (measured to be ~991 Ω).

Measuring length of graphene samples early in the extraction process.

Advice for Future SHINE Students

Potential future SHINE student(s): because there is plenty of help and support within the SHINE community it can become easy to lose track of time and migrate between projects like I have! Although I feel I had a great experience in this program, I wish I would've realized sooner that results—for any project—take time. Choose your research topic before the program, stick to the plan, and reach out for support when you need it! Everyone here is extremely supportive and the Professors aren't nearly as intimidating as I'd expected. If you can follow those simple steps, you'll surely have a great experience here at USC.

Acknowledgements

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