Building a Library of Electron Source Designs for an Integrated Photonic Assisted Electron Emitter

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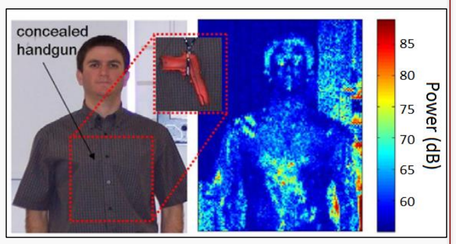
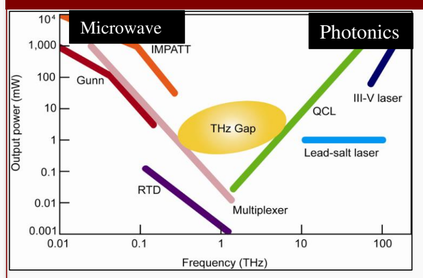
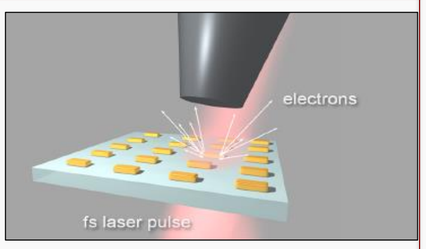
Introduction

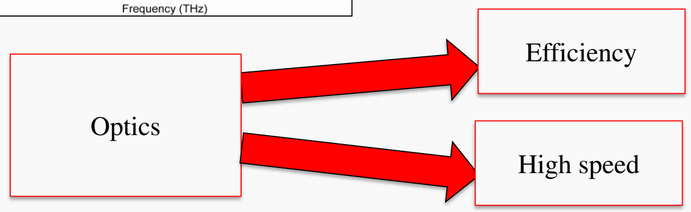


In Professor Kapadia's lab, we are trying to design different types of electron sources that will allow us the have a higher output power at THz (tera-hertz). Currently free space optically driven electron emission, which has a gap between the laser and the metal, is what researchers are using. Researchers want to move to integrated photonic assisted electron emission, where the laser or source is enclosed, which will be more compact and could allow for a greater output power at a THz.

Objectives & Impact of Professor's Research





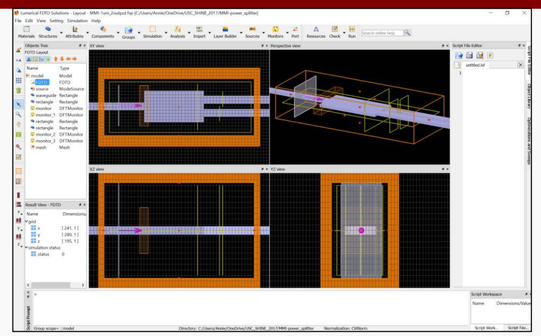


The objective of this research is to create a more compact e^- source. In previous years of research, researchers have only been able to create electronic amplifiers that only provide low output power at THz (10^{12} Hz) and are inefficient, like x-ray imaging machines or machines in an airport that detect if someone has a concealed weapon. Researchers want to create an e^- source that will have a greater amount of output power, it will allow for more power efficiency, and stable emission.

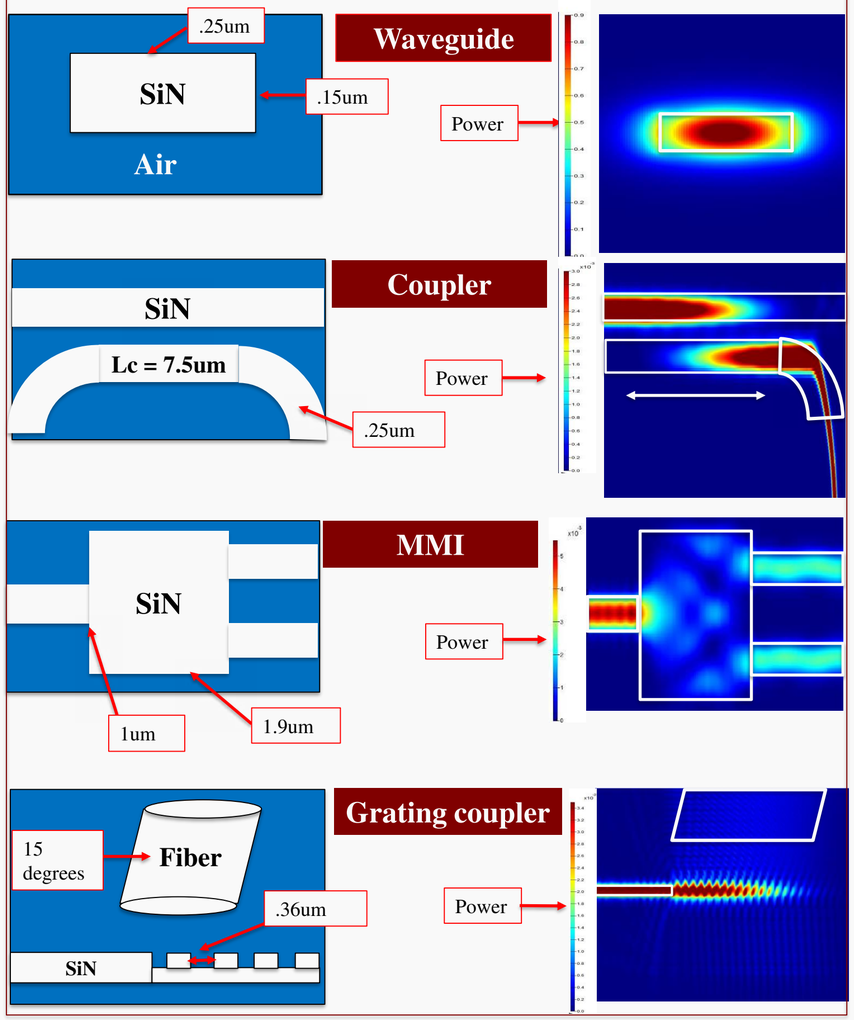
The advantages of using optics for this lab are that the high energy photon exchanges it's energy with an electron which then releases the e^- to the vacuum and the high speed control of the e^- source uses femto sec laser source.

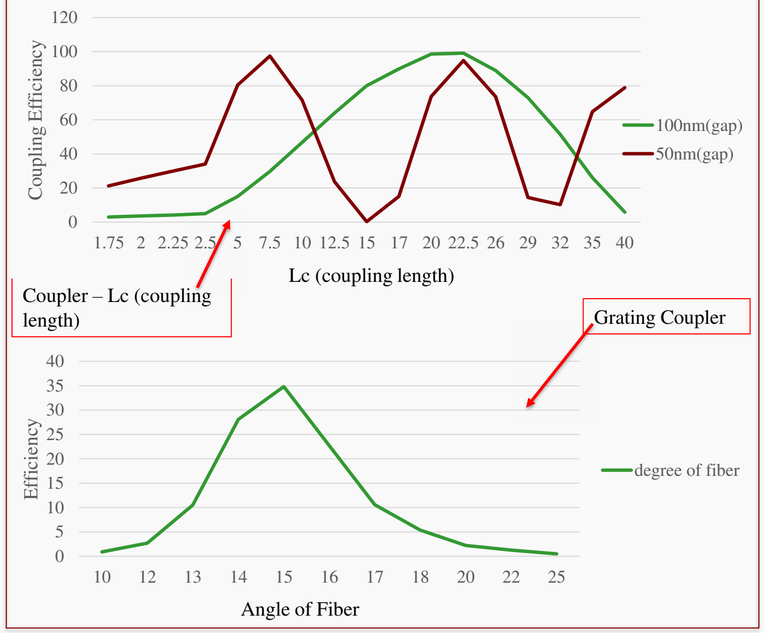
A few of the designs are a waveguide, a coupler, a ring resonator, a MMI optical power splitter, and a grating coupler. To design these different sources we had to use the program Lumerical, which allows us to run numerous simulations. The wavelength that we are working with is 445nm and the material that we are using to design the devices is SiN (Silicon Nitride).

Skills Learned



A skill that I learned in this lab was how to use Lumerical to design a waveguide, a coupler, a MMI power splitter, a ring resonator, and a grating coupler. Along with designing, I learned how to run those programs on HPC to be able to see if the design was working the way it was designed to. Below are examples of what I created, on the left are rough layouts of the designs and on the right are the results from the HPC simulations.



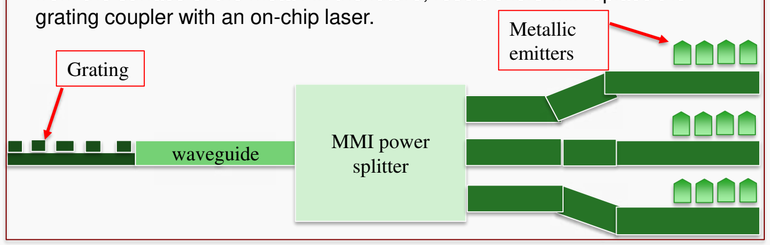


How This Relates to Your STEM Coursework

My small amount of programming experience helped me figure out how to use a new program, Lumerical, and knowledge from AP Chemistry helped me with understanding the basic science behind this project. I can take all that I've learned from my experience in this lab to help me with my high school AP Physics class.

Next Steps for You

The end goal of this project is to be able to combine all these techniques together to make compact e^- source that will have a high power output. Metallic emitters will be added to the end of this device, the photons that pass through this device provide enough energy for the electrons to emit from the surface of the metal. In the future, researchers will replace the grating coupler with an on-chip laser.



Acknowledgement

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