

Verbal background

- Terahertz pulsating laser- a laser that pulsates in terahertz (10^{12})
- Anything and everything we see is light bouncing off of materials and the colors are caused by how the light wave is affected by the material it is bouncing off of
- Mirror types- There were different kinds of mirrors used for the beam path. Unlike mirrors at home that have a 95% reflection rate and some distortion, the dialect mirrors we used had a 99.9% reflection rate and very little distortion.
- Goal- The goal of this experiment is to have the pulses of the laser beam collide perfectly so it undergoes second harmonic generation (SHG) which we could see as three beams coming out of the final crystal rather than two.
- Our mentors and faculty members use terahertz pulsating beams to test the properties of monolayer semiconductors for use in technology.

Graph

By testing different beam path lengths we found the placement of the mirrors that directed the laser into the crystal which allowed it to undergo SHG. We utilized a sensor to measure the amount of light coming through in the place we expected the new combined photon with twice the energy of the initial photons to be. By graphing this reading on the x-axis and the distance we moved the sliding mirrors on the y-axis, we could see at which placement of the mirrors resulted in an energy spike (see bell curve on graph - top is best beam).

Laser map

The laser map shows the path we sent the beam on in order for it to undergo SHG. By using extremely reflective mirrors, we manipulated the beam path without losing very much energy. After leaving the Mira laser, the wavelength of the beam is 800 nm (invisible to the human eye), but once it is sent through the crystal at the end, the beam is 400 nm, meaning we can see more of it with the naked eye because it is half the wavelength and the human eye can only see light within the 380-750 nm spectrum. After the beam is split, one beam goes to the right (in red) and one goes to the left (in blue) towards the sliding mirrors. Although the path shows the laser as two different colors, in reality we only saw a fraction of the light emitted due to the wavelength. The distance of the red line is set, and our job was to set the blue path length so the beam traveled the same distance (and therefore the same amount of time). This step took the most time and patience, making slight adjustments to mirrors in order to change its placement on the final lense. The final lense is used to concentrate the beams together in order to collide in the final crystal and undergo SHG. Using the sensor we could measure the amount of light undergoing SHG and adjust the slider mirrors accordingly to achieve the highest energy level.

Sample map

On the second day, we took microscopic images of the monolayer semiconductor material that is being investigated by Dr. Lee and Viela Guay (our mentors). The materials mentioned include tungsten diselenide (or WSe_2) and molybdenum disulfide (or MoS_2). Mapping out the surface of

the sample provided a better understanding of where the desired monolayer is and where other variations in the sample are located. This information allowed for more precise experiments.

Application

A better understanding of the properties of the monolayer materials could result in major advances in the technological industry. These materials are extremely thin (only a few atoms) and are extremely powerful. The full extent of these materials' properties is unknown but, the research done by Dr. Lee and Viela Guay could uncover new information to help understand the potential these materials have to change the tech world. Today, what computes a computer's information is separate from its memory, making it inefficient. The goal of the monolayer materials is to fully integrate the two processes on an extremely small scale to maximize the energy. Research shows that when the two systems are integrated and separated by nano-meters that they are 1000x more efficient. This could lead to massive advancements and opportunities.

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