Deepak Sharma
IRES2023 Summer Program
Activity Records

Date: 07/12/2023
Activity: Meeting with Professor Doddamani in the School of Mechanical and Materials Engineering
Summary: This meeting consisted of a presentation that outlined the basics of additive manufacturing and highlighted what work is being done at the laboratories of IIT Mandi. Many helpful examples of the benefits of additive manufacturing over traditional subtractive processes were included in this conversation. Professor Doddamani also provided a synopsis of the equipment that the campus has to offer, as well as basic demonstration videos showing how to operate the machinery. Students were also able to interact with different printed objects and parts that are currently being used or optimized.

This presentation gave the IRES students perspective on the extent of the additive manufacturing occurring at IIT Mandi, as well as some basic ideas about common manufacturing processes and the advantages of additive manufacturing. This was also the first event for the students to visit the School of Mechanical and Materials Engineering on campus, so this was a good opportunity to become acquainted with the campus.

Date: 07/13/2023
Activity: Resin printing demonstration in the School of Mechanical and Materials Engineering
Summary: IRES students attended a laboratory in the school of Mechanical and Materials Engineering for a demonstration of resin printing and CAD of different basic structures. PhD students of the lab kindly instructed students about how the printer works, explaining the use of UV laser to harden the resin in place based on properly converted G-code from CAD bodies formed in nTopology software. After this brief introduction, students were split into groups and constructed small rectangular prisms with unique internal lattice structures. Each print took about 15 minutes to complete and the groups cleaned their prints with isopropyl alcohol by hand, though the lab was planning to set up an automatic part-cleaning system soon. Students were then able to compare the apparent strength of each group's print and different lattice structures (body-centered cubic, diamond, and honeycomb).

Through this activity, IRES students were exposed to the basics of resin printing, manufacturing, and post-print procedure. This also provided a tangible example of the impact of lattice on a structure, and how the alteration of a model on nTopology actually impacts the printing process, since students had extensive practice with this software in the weeks prior to this activity.

Date: 07/14/2023
Activity: Visit to iHub and the Drone Laboratory on the North Campus
Summary: On the IIT-Mandi campus, there is a building dedicated to supporting student start-ups and innovation specifically in the realm of human-computer interaction. The IIT system promotes innovation in the realm of HCI at IIT-Mandi, and IRES students were given a brief presentation on this promotion process and what HCI involves. Some of the researchers and innovators at the iHub kindly demonstrated their work to the students, who were able to interact with devices such as VR headsets, flight simulators, and conversational robots.

The IRES students then traveled to a neighboring building to meet the students doing research in the drone laboratory on campus. There was much to see in the realm of monitoring and path-following drones and drone-rover collaboration. The IIT-Mandi students provided the IRES students with

demonstration videos and described the action of each of the projects in the lab; a precursor to the drone workshop to come in the next week.



Date: 07/16/2023
Activity: Screen printing demonstration in the School of Mechanical and Materials Engineering
Summary: Students returned to the resin printing laboratory in the School of Mechanical and Materials Engineering for a demonstration on screen printing. The machine and process showcased are the same as what is used to manufacture solar cells with multiple layers of different “ink” materials. The ink students mixed and used for the demonstration was an ethyl-cellulose ethanol solution with reddish-pink dye. Ph.D. students in the laboratory outlined the use of the screen-printing machine and software used to create the needed stencils for the creation of more precise prints. The IRES students then created their own stencils and placed them on the mesh of the screen printer, following procedure and completing successful screen prints. If a typical project was being performed on the machine, the most time-intensive portion would be the creation of the ink itself, so the process was easily followed by the students. After this activity, some students also visited the solar experimental work space on the roof of the School of Mechanical and Material Engineering building. Here, students were shown different types of solar attenuation apparatuses and weather condition monitoring systems necessary for the research being done.

This demonstration was useful in becoming further acquainted with the equipment of the laboratory as well as the students who work there. The screen-printing activity itself was a good experience to see how solar cells could be manufactured to specific requirements of absorption and performance.

Date: 07/18/2023
Activity: Laboratory Tour of C4CFED, South Campus IIT-Mandi
Summary: IRES students were taken on a tour of the C4DFED center on the IIT-Mandi South Campus so that they could understand what materials and equipment the center employs. The tour and informational

session consisted of five lab rooms, three of which were 100-class clean rooms and two 1000-class, meaning that there could be at most 100 or 1000 particles per cubic foot of the laboratory, respectively.

The first lab contained an ellipsometer, which uses polarized light to measure material layer thickness on top of a substrate at the nano-level, material light absorption coefficient, and material composition. Another piece of equipment in this lab was a scanning electron microscope (SEM), which uses a beam of electrons to scan a sample and record its topology. This device can also cut trenches into the material depending on electron beam concentration. Similarly, an atomic force microscope (AFM) which can image material surfaces, specifically used for coating analysis of size, surface area, and volume distributions. The final piece of equipment in the first laboratory was a helium ion microscope, which can perform lithographic analysis and imaging as well as mill trenches in materials of 1 to 2 nm in depth. For clarity, lithography as referred to here is the affixing or drawing of features onto a substrate.

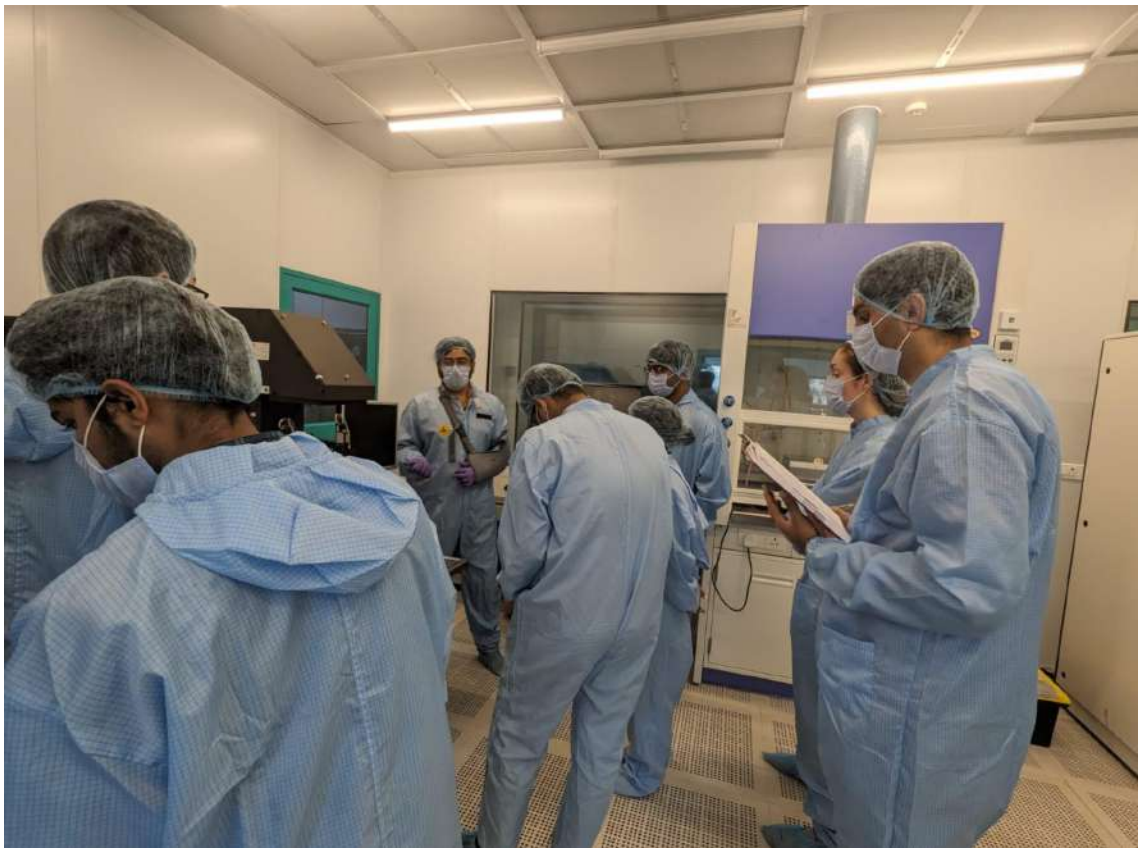
The second 100-class laboratory was dedicated to lithographic analysis, containing optical microscopes with a bit larger viewing field of around 183 nm features. This lab also housed metal organic cluster research projects, where metal particles are used as the core of the cluster and, in this application, polymers were attached to said core.

The third lab, also of 100-class, allowed for further material property analysis such as the water compatibility of a coating. Contact measurement devices tested the hydrophobic or hydrophilic nature of a substance regarding the angle of contact that a water drop maintained with a substance. Therefore, the machine was used to provide a detailed view of the material surface interaction with the droplet and measure the interface angle to infer the bonding / interaction occurring. Another piece of equipment in this laboratory was a spin machine, which used centrifugal forces to spin deposit material onto a substrate. Next to this machine was a glove box, used for volatile or highly reactive microscopic materials. Further testing occurred in the simulated indoor light environment for solar cells rated for compatibility with lower levels of radiation.

The first 1000-class space in the C4DFED facility, the fourth lab visited, housed machines of a higher particle size threshold. The first machine was a thermal evaporator, which uses a metal boat, typically of tungsten, to hold a material nugget of low melting points inside a vacuum chamber such that a current ran through the boat will cause the nugget to evaporate and coat a desired substrate. For materials of higher melting points, this laboratory also contained large sputtering machines which operate similarly to the thermal evaporator. An ion etching machine was also in lab 4, used to remove specific materials from the surface of a substrate, and an atomic layer deposition machine allowed for smaller range deposition thicknesses of less than 10 nm. This type of deposition machine could be used for perovskite layering in an environment similar to atmospheric conditions of later use.

The final laboratory visited was another 1000-class environment, which contained an electron spinning device to generate nanofibers by transferring a solution into a nanofiber structure by electrospinning the solution under a specific electric field. One example provided was the creation of hydrophobic clothing for water repellency. The other machine in this laboratory was a large furnace to anneal any metal and remove internal stresses for further processing.

Overall, the visit to the C4DFED facility was helpful in learning what devices exist on campus for electronic testing and manufacturing, specifically in the realm of transistors or specific solar cells. The students also prepared for entering a clean room environment and made connections with members of the laboratory if the capabilities of the aforementioned equipment would find use in the remainder of the student’s time at IIT-Mandi.



Date: 07/19/2023 through 07/25/2023
Activity: Machine Learning and Image Processing with Professor Parimala Kancharla
Summary: This lecture series focused on a multitude of neural network and machine processing basics, utilizing the coding language Python. Dr. Parimala provided insightful daily lectures on the theory behind image compression, image quality assessment, RGB image specifics, image sensing and computer vision, interpolation / histogram manipulation, and convolution neural networks. Daily assignments were given to students based on the content of the lecture, which provided an exposure to image importing and manipulation including layering, contrast, extracting negatives, foreground and background processing, creating basic XOR neural networks, and attempting to train a self-coded convolution neural network.

Date: 07/26/2023 through 07/31/2023
Activity: "Bootcamp for Drone Technology" conducted by the Centre for Artificial Intelligence & Robotics at IIT Mandi
Summary: Students participated in a 6-day drone workshop consisting of a combination of lecture and hands-on laboratory sessions. Topics from hardware, to software, to mathematical modeling of flight and referential motion mechanics were covered and applied to tangible construction of a quadcopter unmanned vehicle. Participants were able to fly their drone and assess their efficacy in following vague manual directions for construction, as well as their understanding of calibration and graphical user interface (GUI) systems. A final assessment was given to monitor student ability and the clarity / engagement of the bootcamp instruction. The provided daily schedule is included below.

Daily Schedule:

Day	10:00 AM to 12:00 PM	12:00 PM to 1:00 PM	1:00 PM to 5:00 PM
Wednesday (July 26)	Inaugural Ceremony Indoor Demonstrations: Demo1:DJI Air 2S Demo 2: Tello Demo 3: Crazy fly	**Lunch Break**	FDP Lab Visit & PPT (Video) Drone Lab Visit & Outdoor Demonstrations Near the Drone Lab. Demo 1:Horizontal structure tracking Demo 2: Fire Fighting drone / FPV Drone Demo 3:UGV/UAV Collaboration
Thursday (July 27)	Introduction to Drone Technology	**Lunch Break**	Hands on (Basic component of Drone, types of drones and literature, Drone Frame, Motors, ESCs and propeller selection, power distribution board)

Friday (July 28)	Kinematics & Dynamic Modelling	**Lunch Break**	Hands on (Power module, batteries and battery charging, Introduction to flight controller, Communication protocol, RCs, and Connections)
Saturday (July 29)	Coordinate frame and transforms with ROS	**Lunch Break**	Hands on (Sensor calibration and software (QGround control and mission planner), Onboard Computers, Communication between flight controller and onboard computer, Simulation)
Sunday (July 30)	Control Algorithms	**Lunch Break**	Hands on (Analysis of parameters, Log file analysis, Flight test of Drone, Precheck list and post check list of drone)
Monday (July 31)	Assessment Test, Certificate Distribution, Group Photograph, and Announcement of top 3 performers	**Lunch Break**	Demonstrations from the participants side, token of gift to top performers, and concluding remarks

Date: 08/1/2023 and 08/2/2023
Activity: Silicon Wafer Construction Demonstrations at the C4DFED at IIT Mandi
Summary: For 2 days, students were present during the fabrication of silicon wafers for electrical application at the Center for Design and Fabrication of Electronic Devices (C4DFED) and IIT Mandi South Campus. PhD scholars talked the students through the preparation and fabrication process, answering any questions and elaborating on the use of certain techniques on a topic-wide manufacturing level.