

## ECEn 555 – Optoelectronics Devices Lab

### Week 7

#### “Preparing to work with III-V semiconductors”

In this lab you will prepare to work with the III-V semiconductors you will use to make emitter devices (LEDs and lasers). This semiconductor material is much more expensive than the silicon wafers you have worked with so far. As such, we typically don't work with entire III-V wafers when doing research work with these types of devices – or doing instructional laboratory work as you are doing. Wafers will be broken into small “chips” about 1 cm x 1 cm and you need to get some practice working with them. The chips will be smaller than what you are used to, and also more fragile than silicon. When making LEDs, the substrate will be GaAs; when making lasers, the substrate will be InP. InP is the most fragile, but both of these will shatter quite easily if you drop them from any significant height. Before turning over any of our precious III-V material to you, we want you to practice working with some small silicon pieces.

#### Major Objectives

1. Mounting Small Pieces. Using a silicon wafer cleave up several 1 cm x 1 cm pieces. Because our aligners and spinners are built for 4” wafers, to do lithography on these pieces you are going to have to mount them to 4” wafers. To do so, you will use photoresist as your “glue”. Practice doing this by putting a single drop of AZ3330 in the middle of a silicon wafer. Place your 1cm x 1cm chip on top of the resist and make sure it is flat by pressing it against the wafer and moving it around slightly. When you are satisfied it is flat, bake your photoresist at 90C for 5 minutes to lock the chip in place. Verify that the chip is mounted well by pushing against it with your tweezers. Also practice demounting the chip by placing acetone on the chip and gently pushing it off the 4” wafer.
2. Lithography on Small Pieces. Mount some small pieces on a 4” silicon wafers as described in the first objective. Place the 4” wafer in the spinner and place a few drops of AZ3330 photoresist on the small mounted piece. Spin the resist to thin it out then bake the resist on a hotplate at 90C for 1 minute. Place the 4” wafer in the aligner together with the LED mask you will use next week. (Turn down the pressure on the aligner chuck so you don't damage your chip or the mask since you are greatly reducing the surface area in contact with the mask). Expose the resist and develop the pattern.
3. Metal Evaporation and Liftoff. Dip the small piece and 4” wafer into BHF to remove and surface oxide and then blow dry with nitrogen. Now do a 30 second O<sub>2</sub> plasma descum in the LFE to remove any surface contamination. Load your small piece and 4” inch wafer into the thermal evaporator along with aluminum wrapped around a tungsten boat, the lab supervisor will show you how to do this. Pump down the chamber, and then evaporate the aluminum over the surface (300 nm) – as you will do in making LEDs next week. After evaporation, remove the wafer and place it in acetone. This will “lift off” aluminum evaporated onto photoresist and leave only aluminum that was in contact with the semiconductor. The lithography pattern should now be clearly visible as aluminum on the semiconductor.