# Materials Science & Engineering Thesis Defense

## Magnesiothermic Conversion of Sintered-Closely Packed Diatom (Coscinodiscus wailesii) Monolayer on Silicon Wafer and its Optical Properties.

School for Engineering of Matter, Transport and Energy

Srisuda Rojsatien

**Advisor:** Dr. Michael Goryll

## abstract

The hierarchical silica structure of Coscinodiscus wailesii diatom was studied due to its intriguing optical properties. To bring the diatom into light harvesting applications, three-crucial factors were investigated including closely-packed diatom monolayer formation, bonding of the diatoms on a substrate, and silicon diatom production.

The closely-packed monolayer of the diatom valves was formed on silicon substrate using their floating properties and high surface tension of water. The dispersed valves on hydrophobic surface were able to float-up with preferable orientation (convex side floated on water surface) when water was added on them. The floating diatom monolayer with controllable dimension were easily lifted up by a silicon substrate. A closely-packed diatom monolayer on the substrate was obtained after the water evaporated at room temperature.

The diatom monolayer was then directly bonded into the substrate via sintering process at high temperature in air. The percent of the bonded valves was increase as the temperature increased. The valves started to sinter into the substrate at 1100°C. The sintering process caused shrinkage in nano-micro pores. The more delicate structure was more sensible to the high temperature. The cribellum, the most intricate nanostructure of the diatom (~50 nm), disappeared at 1125°C. The cribrum, ~100-300 nm pores, disappeared at 1150°C. The areola, the micro-chamber-liked structure, can survive up to 1150°C. At 1200°C, all of the structure was destroyed. In addition, cross-section images revealed that the valves were fuse into the thermally-grown oxide layer generated in the substrate at the high temperatures.

The silica-sintered diatom (from 1125°C) was magnesiothermically converted into porous silicon using magnesium silicide. X-ray diffraction, infrared absorption, energy dispersive X-say spectra and secondary electron images confirmed the formation Si diatom with preserved nano-microstructure. The conversion process and PEDOT:PSS coating decreased its light reflection. The photoresponse and reflectance spectra revealed that the Si-diatom dominantly enhanced light absorption at around 414 to 586 nm and 730 to 800 nm. Though some of its features were disappeared during the sintering process, the diatom still be able to improve light absorption. Therefore, the sintering process may be used for diatom direct bonding for light harvesting applications.

April 13, 2018; 11 AM; LSA 119