## Internship Opportunity 2024 - Prima Innotech LLC

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| **Project:** | **Process Development and Testing** |
| **Description:** | The objective is to develop and test processes for bonding of exfoliated thin films to a substrate. |
| **Details:** | We are looking to hire 1 - 2 student interns to work on various aspects of these projects. ChemE, EE, and Mat. Sci. are preferred.<br><br>The duration of the internship is 3 months and is likely extendible to the following semester. Each intern will work on selected aspects of the development and testing. The desired time commitment is 24 - 40 hours / week during inter-semester breaks, and 10 - 20 hours / week during the semester. Most of the internship will be completed on campus using fabrication faciliites and labs at the institute.<br><br>The intern will submit a biweekly report that includes a time-sheet and attend a weekly review meeting. Interns will be compensated biweekly (via Paypal) based on the timesheet at $5 / hour for time spent on deliverables. A per-diem allowance will be paid to cover typical lodging and boarding expenses while on campus during the inter-semester break.<br><br>All internship offers will be preceded by a paid assignment to confirm interest in the project, access to design tools and / or software to complete the project, ability to execute remotely and semi-independently, and availability of time to execute the project. This assignment is limited to completion of the deliverables, 40 hours, or 4 weeks whatever comes first, and applicants will be compensated $100 upon presentation of the report. |
| **Skills:** | The intern should have completed core courses in mathematics (linear algebra, differential equations, transforms), physics (mechanics, EM theory), engineering mechanics, strength of materials, circuits, and computer science (algorithms, programming, embedded control) and have a working knowledge of tools (e.g. Matlab, SolidWorks). The intern should be analytical, meticulous, accountable, results-oriented, and a self-learner.<br><br>All the tasks in this internship are development-oriented and will involve defining the problem statement, starting with high-level requirements, and cascading these to lowerlevel requirements that must be fulfilled through the appropriate design. As in any realworld engineering problem, these projects are open-ended (or semi-defined) and there is no single right solution. Based on objectives, the intern will define the problem statement, relevant constraints, and assumptions. and iterate to arrive at a self-consistent solution based on engineering judgement. Independent thinking and application of relevant engineering principles are important for successful completion of the deliverables. |
| **Start Date:** | Start of inter-semester break (a 1 week delay may be granted if necessary). |
| **Location:** | On-campus since CeNSE facilities will be used. |

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| **Company:** | Prima Innotech LLC based in New Jersey, USA develops and commercializes innovative technology by leveraging expertise and capabilities of a global network of institutions. Presently, it is developing GaN based System-on-Chip technology for power conversion and RF applications based on the heterogeneous integration of thin films. |
| **Application:** | Please submit resume and statement of interest to prima.innotech@gmail.com. |

## Pre-Internship Assignment for the Bonding of Exfoliated Films

The objective of the internship project is to develop a process sequence for the bonding of exfoliated films. The process sequence consists of: cleaning the surfaces that have to be bonded, depositing the films that will serve as the bonding interface, polishing the resulting surfaces to achieve a low surface roughness, bonding the two surfaces, and annealing the bonded structure to strengthen the bond. The development will be performed on 4" (100 mm) wafers using lab facilities at the institute.

As a pre-internship assignment for the development of the process sequence, the applicant will survey the processing tools (with associated processes), and the metrology / characterization tools required for the process development. These include:

- Wet process benches and associated processes for cleaning and drying of bare Si wafers and Si wafers with dielectric films ($SiO_2$, SiN, SiCN, $Al_2O_3$).
- LPCVD, PECVD and ALD tools and associated processes for depositing dielectric films ($SiO_2$, SiN, SiCN, $Al_2O_3$) required for electrically insulating bonds.
- PVD (sputtering) tools and associated processes for depositing metal and semiconductor films (Ti, Ni, Pt, Si) required for electrically conductive bonds.
- Polishing tool (CMP) for achieving the desired surface roughness prior to bonding.
- Bonding station (for wafer-to-wafer or chip to wafer or chip to chip permanent bonding) and associated processes for activation of the surfaces followed by bonding.
- Annealing tool (furnace or Rapid Thermal Processing) for recommended annealing after bonding.
- Metrology and characterization tools for surface roughness (AFM), dielectric film thickness (ellipsometer, reflectometer), and wafer flatness (optical or physical profilometer).
- Review the papers from IBM on spalling (authored by S. Bedell and others) to get a general understanding of the theory of spalling, the experimental conditions to achieve spalling on various film / substrate combinations, the transfer of the exfoliated film to another substrate, and applications of spalling. Spalling is a type of exfoliation process. Summarize the key points. Review the assigned set of papers (published by other groups) to gain further insights into the transfer of the exfoliated film to another substrate including experimental methods, experimental conditions, and experimental results. Summarize your findings. Most papers are available online or should be accessible through the institute library. I will purchase the others that are available online.
- Prepare and present the pre-internship assignment. A PowerPoint presentation is adequate.

For each process tool include the availability, cost for industrial use, training requirements, and relevant capability and performance metrics to assess suitability for the targeted processes.

Complete as much of the assignment as possible within the 4 week and 40-hour time limit.