Dead Line: January 4th

In your statement of purpose, you should succinctly describe your reasons for applying to the proposed program, which may include:

* Preparation for this field of study
* Motivation for graduate study
* Why our program is a good fit for you
* Future career plans
* Other relevant aspects of your background and interests
* Interest in specific research or faculty members at Stanford

Remember in your Statement of Purpose, we want to get a snapshot of YOU (in two pages or less – single space, 11-12pt font, 1-inch margins is acceptable). For example:

* ∙  What made you decide to apply for the Materials Science program? What are your aims/goals?
* ∙  What kind of courses, work, or research have you done that directly relate to your aims/goals?
* ∙  What are your future plans, and how can our Materials Science program help you get there?
* ∙  Is there anything we need to know about you that you think make you stand out from others?

Graphical user interface

Description automatically generated with low confidence

**Figure 1.** Research findings. (a) The size distribution and the optical absorption spectrum of nanodroplets; (b) The ultrasound images before and after nanodroplets activation; (c) The photoacoustic images before and after nanodroplets activation. The scale bar is 1 mm. (~360 nm size). (d) Hysteresis loops of multi-layered films measured at room temperature for Ta(1 nm)/Pt(5 nm)/[Co(0.3 nm)/Pt(1 nm)]10/Pt(1 nm).

**Statement of Purpose:**

As a first-generation college student, participating in research is a huge milestone. I consider the opportunity to work on cutting edge scientific problems to be a privilege that I am very thankful for. While I focused more on building my theoretical fundamentals in my first year through taking courses, I knew that I would learn much more about science and innovation by actually getting involved in research. I also decided to try multiple research areas to find one that truly resonates with my strength, interest, and view of the future.

Throughout my journey in nanotechnology research, I have been involved in several projects, one of which involved the fabrication of stable microbubbles and nanodroplets for ultrasound imaging applications in Prof. Zhao’s group at UIUC. My task was to fabricate highly stable lipid-shell microbubbles by fine-tuning the concentration of the reactants such that they can stay in the target’s blood circulation system longer than 6 minutes before getting dissolved. I also ensured the uniformity of the bubbles’ size because the contrast enhancement is size-dependent; hence, I applied the differential centrifugation technique to separate the larger microbubbles from the smaller ones. The success of the development of highly stable microbubble contrast agents resulted in our group being highlighted in the World Molecular Imaging Congress 2021. Since then, I became more confident in doing research and curious to take on new projects related to nanotechnology.

In Fall 2020, I learned about neuromorphic chips from a seminar by Artha Telekomindo, a leading Indonesia-based Information Technology company. The topic piqued my interest because these chips consume significantly less power than current supercomputers to perform complex calculations and can be a breakthrough technology in the high-performance computing space. My grandfather’s death due to a car accident has been the motivation for me to improve car safety through engineering, and I learned about the possibility of implementing these neuromorphic chips for AI-assisted car safety systems. My goal is to create a start-up that commercializes this technology to reduce car accident rates globally.

Therefore, I went to UIUC site, searched for faculty members working neuromorphic computing, and found Prof Axel Hoffmann. Additionally, I also learned during my search that his post-doctoral fellow, Dr. Jonathan Gibbons, who later became my mentor, is a member of the Quantum Materials for Energy Efficient Neuromorphic Computing (QMEENC). My main goals for working in this group are to obtain a hands-on experience in fabricating neuromorphic devices and direct guidance from the experts in this field. With the support of my first research advisor, I joined the Hoffmann Research Group. This is the only research group in UIUC working on neuromorphic chips based on magnetic materials. In this group, I performed thin film growth through the sputtering technique and optimized the magnetic materials that can be used as spin torque oscillators. These devices have promising implementation schemes for neuromorphic computing as they can mimic the functioning of the neural system through complex dynamics that arise from the interactions between individual oscillators. The goal of my project is to optimize the thickness, the number of layers, and growth parameters of Co-Pt multilayer thin films for a high perpendicular magnetic anisotropy (PMA). The Co-Pt sample is characterized using the vibrating sample magnetometer to observe the magnetization by obtaining the hysteresis curve. After several iterations, I obtained a high level of perpendicular magnetization that allowed me to incorporate these films into neuromorphic devices or magnetic memory.

My excitement in performing device fabrication and materials characterization did not stop there; I began to fabricate the spin torque oscillator devices. In this project, I started by performing a nanofabrication technique to create the devices. I performed e-beam lithography to create the pattern of the device. Though I kept encountering errors with the dimension of the pattern and the sample preparation process in the beginning of the project, I reached out to the facility manager and worked together rigorously until we obtained a solution to the problems. Afterwards, I deposited Permalloy and platinum by sputtering technique and performed the lift-off process to release the device. The ultimate goal is to characterize the magnetization dynamics both optically and electrically, which has been my focus in the last few weeks. If successful, these spin torque oscillators will be implemented for neuromorphic devices or chips.

In Spring 2021, I took a nanotechnology course with Prof. Joseph Lyding and had an open-ended project proposal, where I chose novel memristor devices based on 2D phase-change materials for neuromorphic computing applications. I liked the topic and decided to work on neuromorphic devices for my master’s program. I saw the potential of implementing different materials to fabricate the device and broaden its functionality, such as using polymer, magnetic, oxides, and semiconductor materials. While having experience on fabricating the device using magnetic materials, I would like to have the opportunity to create polymer-based or phase change materials-based neuromorphic devices where I can directly apply my knowledge of transport phenomena, chemistry of materials, electrochemical engineering, and nanofabrication techniques. Therefore, I would like to work with Prof. Alberto Salleo or Prof. Philip Wong, the two groups at Stanford MSE and EE, respectively, who are innovating the neuromorphic technologies. I believe that the Salleo research group is the only group in the US that work on polymer-based neuromorphic device.

I am interested in the fabrication of crossbar-structured memristor devices utilizing a functionalized organic material for the electrodes that can be used for high-performance artificial neural network accelerators. I would also like to incorporate nanoelectromechanical devices into the memory to help address challenges due to scaling, such as sub-threshold leakage. To push the frontier of neuromorphic devices, I aim to have a deeper understanding of materials characterization, design, and fabrication, which are key concepts in materials innovation.

I believe Stanford MSE master’s program and the unparalleled courses that are not available elsewhere would help me achieve my goal. In particular, I would like to take Materials Advances in Neurotechnology (MATSCI 384) and Nanocharacterization of Materials (MATSCI 320), both are important courses that will advance my knowledge in nanotechnology and neuroengineering to create a breakthrough in the neuromorphic field. Additionally, I appreciate the opportunity to take the Strategy in Technology-Based Companies (MS&E 270) course from the Stanford GSB department. This course is extremely important because I need a deeper understanding of competitive positioning and co-operation concepts to strive in a pool of neuromorphic computing startups in Silicon Valley. Further, due to its interdisciplinary nature, neuromorphic technology requires a diverse understanding from various fields. The Nanolab facility is the best place to work alongside other Stanford groups to lay the foundation of my pursuit of building a start-up.

Lastly, throughout my research journey, I have worked in the Chemical Engineering, Material Science, and Electrical Engineering departments. Fostering ideas from diverse engineering fields to innovate in the material science space is where Stanford MSE’s and my vision align. Therefore, my motivation, entrepreneurial goal, and diverse research background are a perfect fit for Stanford MSE.