Statement of Purpose

-My motivation and research experience

I liked to read science magazines when I was young, so my parents booked 6 along my childhood. Since the first time I read about Scientific American Chinese Edition in 2006, I have been fascinated by the power of advanced technology. In high school, I found science is the drive behind the technology and I fell greatly attracted. After college, my goal is to shorten the marathon between researches and innovative technology. For example, I am impressed by the nano science but I found there is still a distance from systematic application.

To achieve my goal, I think the first step would be building up my systematic thinking and gain insights into innovative research. At the same time, I tried to understand and learn to push forward the frontier. Finally, I start from my research domain to study and accelerate such transformation. These concerns drive me to purse a PhD research. I felt my heart calling when I found the research picture on world-class universities' websites looks just the same as my 2006 Scientific American. So I can work on my childhood dream? It is unbelievable.

I followed my curiosity to locate my research interest. In sophomore, I was absorbed in simulation from the course of fluid dynamics, therefore my first research is about simulating flow distribution effects on porous media thermocline thermal storage. To validate our unexpected results, I retrieved the Purdue papers. Following their method to validate the unexpected results, the entropy generation was too trivial, and not negatively responded to our heat output. So there should be something missing. Exactly! The equations within every phase were correct, but the authors missed the dominant entropy generated by fluid and solid heat transfer. Why they would do so? There is a possibility that researcher got trapped by the formulation and neglect the physics. Admittedly, simulation is powerful since it enables us to predict and to control. But now I realized a rigorous physics scan is always the first step before simulation. This work now has been under review in ***Applied Energy***. I cherish it since it prepared me to research independently and keep a high spirit with failures.

Gradually, I was not satisfied with continuum theories, which does not reach microscale. But MD and LBM as micro scale tools still rarely help me to build physical intuition. So I switched to a Laser-introduced Breakdown Spectroscopy lab for a bite of experimental work. However, the lab focused on error reduction not the physics, which did not attracts me further. Next step is to locate interesting physics. In Purdue Cooling Technology Research Center, I found something fascinating. Cooling has multiple transport interfaces and micro scale transport becomes critical. "Look, the droplet contact line is jumping!" The view of morphology transition of micro droplet evaporating on a nanostructured surface was as impressive as yesterday. Just like the micro scale transport, we still know two little about the nature.

Besides, I modeled how heterogeneity will change the properties of fluids, which was the best intellectual enjoyment I ever had. My work was to compare the microchannel two-phase flow impedance measurement to the theories. But I found all the predictions were isolated without a higher framework and I could not start. Thanks to Prof. Garimella's advice of considering Effective Medium Theories, I put EMT as a variable into the container (the impedance equation), then I produced a generalized formulation. But the complicated equations were not coherent with literature’s simplicity. After I invented dimensionless number L to indicate the relative ratio of pure fluid capacitance and admittance, and P, the ratio of EMT counterparts, the equations could be reduced according to L and P comparison. Naturally, L and P indicates the effects of fluid properties and different EMT models. For the latter concern, through comparison I found EMTs with plate elements were more effective for slug flow and EMTs with sphere elements works better for bubbly flow. There remains interesting correlations to be studied. Finally, I drew predictions for robust sensor design. Surprisingly, modeling, validating and predicting all originated from an idea of solid-fluid analogy. “Do you believe that it’s done by an undergraduate in 5 weeks?” said Prof. Garimella after my presentation. At that time, I felt the core of research: by modeling the unknown world we try to predict the reality. It makes me believe I am capable of conducting PhD research.

Future technology will definitely evolve into a "multi-" and “micro-” world with catastrophic emphasize on integration of micro components. Consequently, understanding microscale transport is essential. According to my experiences and goal, for PhD I hope to research on nanoscale thermal transport and complex fluid, which are two major issues for solid and fluid transport.

In the future, I would love to be a scientist exploring a field with rare people and probably working on an interdisciplinary direction. From my startup experience, I learnt to pinpoint a field with most opportunity and be less afraid of failure. I hope this can make me a better fit for challenging PhD topics.