

**National Science Foundation U.S/ China**  
International Research Experience for Students Program  
Summer 2010  
Student Report

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September 1, 2010

## **Background**

In the last few decades the Chinese people have embraced technology and modernized more quickly than some western countries have. As such, it is important for people of other countries learn how to engage and cooperate with their Chinese counterparts. With the sponsorship of the National Science Foundation (NSF) and the guidance of professor Albert Wang of the University of California, Riverside (UCR) campus, the International Research Experience for Students (IRES) program is an annual program that focuses on recruiting students to take part in an international research opportunity in China. This program has been running for three years. Each year four students are picked from a pool of applicants and given grants to defray costs of the program. The connections forged in China by Professor Wang are the basis upon where the students go for the program. The opportunities provided by this program to the students involved include learning how Western and East Asian cultures differ on food, living arrangements, and values.

## **Goals**

- Teach students about proper research in the field of microelectronics
- Develop a better understanding of how to solve unexpected problems.
- To create a productive environment for dealing with different methods of completing similar tasks.
- To create a once in a lifetime opportunity for students to experience the cultures of foreign lands.
- To strengthen relations between United States of America and China

## **Pre-departure**

### **Technical Orientation**

In the weeks prior to our departure, we were required to attend a weekly technical orientation. The orientations were an hour long, and it covered different aspects of the wafer fabrication. The orientation was administered by Professor Wang's graduate students in his lab L.I.C.S. (Laboratory for Integrated Circuits and Systems). The orientation helped the team members to get acquainted with one another, with the terminology, and some of the tools that might be present during the research internship.

### **Cultural Orientation**

We also attended a cultural orientation to familiarize ourselves with Chinese culture. The cultural orientation prepared us for the new customs and traditions we would encounter while in China. University of California Riverside Developmental Advisor Jun Wang hosted the orientation, and he also gave us a hand out with important information on Chinese culture, basic phrases.

## **Departure**

Commuting from Riverside to Los Angeles was not a pleasant task. Therefore we decided to carpool. Roseblim's mom picked everyone up at UCR except David because he would fly in to L.A.X. from San Francisco. We planned for the worst-case scenario, as L.A. traffic is very unpleasant and unpredictable, but we ended up having absolutely no traffic and

arrived at the airport with more than enough time on our hands.

We waited for hours for the Air China terminal to open and have our bags checked in. After waiting and having our bags pass through security we finally took our flight at 1:00am, and we would be in the air for the next 12 hours. It was a long flight; and this was only a taste of what we would expect once in China. Everyone on the plane spoke Chinese except Cody, Isaac, and Roseblim. It was a bit of culture shock to see so many Chinese people gathered in one spot, and not to be able to understand a single word they said. It was also hard to strike up a conversation with the surrounding passengers since they did not speak very well English, and we did not speak very well Chinese. We arrived at Beijing Wednesday morning.

### **Arrival to Beijing**

When we arrived to Beijing it was like any other airport, we got off the plane and walked down the connecting tunnel into the building. What we saw at the end of the tunnel took us aback! It was a very modern airport, unlike anything we had seen before. The roof was so high; it seemed more like a stadium than an airport. We could not see any pillars or columns keeping the ceiling up. It almost seemed like the ceiling was floating. Equally amazing was the fact that the airport has its own trolley to transport passengers, and its a fast moving train too.

Professor Albert Wang was at the airport with Peng, one of the host students from Tsinghua University, and they quickly helped us get our baggage onto a rented van. The airport is on the outskirts of Beijing; so we were able to sight see while we headed to the university. We quickly saw that Beijing is a very well developed city, with many high-rise homes and buildings already constructed.

When we arrived at Tsinghua, we had to check in and obtain a key to our rooms. We also had to obtain a meal card, bicycles, Internet card, washing machine card, and supplies like food and water. It was a lot of simple tasks that took us a couple of days to accomplish since for some of us it was our first encounter with jet lag.

### **Welcome Dinner**

The welcome dinner was a great way to dive right into the Chinese culture. We got to meet some of the host students that later throughout the trip helped us out in the lab or around the city. It also helped break the ice. For Roseblim, it was the first time he ate with chop sticks, and after a bit of peer pressure he embraced the use of the chop sticks for the rest of the trip leaving behind at the restaurant his personal spoon and fork. Using chopsticks was really challenging at first, but it became second nature after practicing for a few days.

The meal at the restaurant was unlike anything we had ever experienced. It is not even remotely close to Chinese food in America, for starters we had a rotating glass centerpiece that allowed the food to rotate freely and be within arms reach of everyone. All one had to do was rotate the center piece until we had the desired food item in front and take it directly with one's chop sticks. In Chinese culture it is customary to eat this way and share the different plates of food with one's guests. The host students were very welcoming and eager to learn about American culture. We were



also eager to learn all about Chinese culture and what kind of research the graduate students were working on, since they would be taking us under their wings. We could not wait to go to the lab and get to work.

### **The Forbidden City and Historical sites**

The Forbidden City is a site that we all have heard about at one time or another; we have seen documentaries, movies, or at least seen pictures in a magazine or on the Internet. It looks really impressive in any kind of media, but to actually be there in person and being able to touch and walk on such a historic site is priceless. We walked for hours, exploring all the alleyways and passages, and we only got to see a fraction of the site.

We also visited Tiananmen Square, which is one of the largest open area spaces, and it was right outside the Forbidden City. It is interesting to note that Roseblim took an anthropology class that dealt with spaces, and Tiananmen Square and the Forbidden City came up in that class continuously. It was amazing to read about it in the textbook, see the slides, and then a week later to be at the site. Other visited sites include:



#### I) Forbidden City

- II) Tiananmen Square
- III) Peking University
- IV) New Summer Palace
- V) Olympic Center
- VI) Police Museum
- VII) Military Museum
- VIII) Art District
- IX) Llama Temple
- X) Confucius Temple
- XI) Baijai Park
- XII) Ethnicity museum
- XIII) Great Wall
- XIV) Beijing Zoo
- XV) Science Museum
- XVI) Blue Zoo Beijing (aquarium)
- XVII) Temple of Heaven
- XVIII) Railway Museum



### **Chinese Culture Club**

We also attended a Chinese culture club that was offered by a group of volunteers at Tusk Park. It was not a school activity but they target foreigners who want to learn the Chinese

language and customs. There we learned about the ceremony and importance of tea, and how different types of tea help cure or ease different types of health conditions. They also taught us the proper way to drink tea and how to meditate after drinking tea. We also were shown the Chinese guitar and taught how to paint with water and ink. Unfortunately it was towards the end of our trip when we started to go to the Chinese culture club, because they were very interesting and we all looked forward to going to those cultural gathering.

## Chinese Cuisine & Culture

Chinese cuisine is one of the world's best. Through Chinese cuisine we are able to better understand the rich cultural and the fascinating history of the country. Our first real encounter with Chinese food was breakfast at one of the many dining halls in Tsinghua University. We were starving after more than 12 hours of plane ride, so we were eager to begin our first meal in China. However, when we arrived at the dining hall we were faced countless amounts of choices. The dining hall was four stories high and each floor features a unique style of Chinese cuisine (because China is so large, type of diet differs by location). On each floor there were many different windows offering different kind of food. Even for breakfast there were many options to choose from. We followed our host students as they showed us how to order food here. Then through a long process we picked out our first meal.



Surprisingly, food here is extremely cheap, compared to the average cost of a meal in the United States. Our daily spending on food was only around 10 dollars. In the 37 days period we tried to experience all the unique and interesting food that China has to offer. We visited street vendors. We were first afraid of the quality of the food but after our first bite that concern immediately faded. The taste was just simply amazing.



We also went to both high-end luxurious and vegetarian restaurants, each giving us a different prospective of Chinese cuisine.



While we were there we also went to China's more exotic parts. We went to Wangfujing Street, Beijing's largest shopping district. Within that district lays a food street, offering unthinkable foods such as spiders, scorpions, grasshoppers, starfish, seahorses and many more.



We decided to have a try at the frightening fried scorpions. The scorpions were still alive and moving before it was fried on a flat pan right before our eyes. The taste was much unexpected. It didn't taste like anything, except it for the crunchy exoskeleton. We tried donkey and dog meat, which we purchased at school's convenience store. We also tried out the famous Beijing ducks. It was a true delicacy that we will be missing in the States.



**Guests in China**

Chinese culture and tradition have lasted thousands of years. Through these years the Chinese always kept their customs of honoring their guest. The Chinese always give the upmost treatment to their guest. Our host students showed us that traditional value. Through these 30 some days, the students at Tsinghua have treated us like a family. They would constantly invite us to activity and events. Whenever we needed help they would come and assists us. We really appreciated their treatment.



### **Experiencing the life in Beijing**

On our third day at Beijing we decided to take our rented bikes on a tour in Beijing. We thought it would be a good chance to experience the life and custom in China. We left our dorm buildings and from the university's gate we headed south.



One of the first things we noticed is how many people there are on the streets. Streets were crowded with cars and bikes, street walks packed with people and vendors. Of course, China has the world's largest population, but we never realized how large it actually was until we saw the situation on the street.

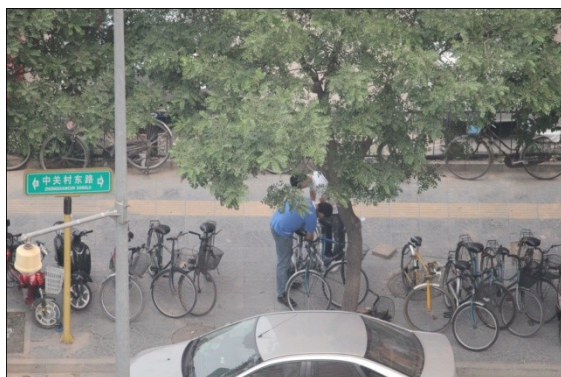
While we biked through the streets we got see what the local life was like. We even discovered a couple of hudong. Hutongs were alleyways featuring the traditional courtyard also known as siheyuan.



Nowadays few traditional hutongs still exist. However, the newer Hutongs were probably the best representation of the local life style in China. The layout of the hutong is very interesting. The restaurants, vendors and other businesses that took place in the hutong made it very lively. People were all busy managing their own little business. Many who live in the hutong were staring at us as we biked along. We drew quiet an attention in this little part of the town. The life in the hutong is rich and exciting. In the end we even stopped by a fruit vendor to bargain for some juicy cherries.



Bikes are a big part of common Chinese people's life. To these people, bikes are their main daily transportation. In this busy and crowded city, bikes are the easiest and cheapest form transportation. Especially in Tsinghua University, where a bike is a must have for every student. The campus is so large that it is impossible to walk to class everyday. Bikes are also the most stolen item in Beijing. According to the host students, it is common to lose a few bikes in a school year.





## Lab Research

### The Clean Room

The labs focused on different stages in the fabrication process of the wafer. It all took place in the Micro and Nano electronics building at Tsinghua University. Every time we went in we had to suit up with the proper attire. The suits help keep the amount of particles in the clean room at a low level. Before we could enter the clean room we must step on a sticky mat and pass through a two-door room the size of a small closet. Once in there air is blown from all directions to blow off any particles that may be on us. Everyone must pass through one at a time, it is very tiny and one might feel a bit claustrophobic inside. This tiny room isolates the air from the exterior with the air from the lab. This was the first time any of us had been in a clean room, and have taken part in a working laboratory.

### Working on Silicon Wafers

The silicon wafers that were used were 4 inches in diameter each. They are very delicate and can easily crack and break if not handled properly. We never physically touched one either because the oils in our hands would permanently contaminate the wafer. We always had to handle the wafers from the edges and with a pair of pliers, and despite the fact that we were in a clean room we always had to place the wafer in its protective cover when not in use.

### Equipment

At various stages of the production we needed to apply heat to the wafers. Depending on the stage and the material that was being applied it would go into a small oven that quickly reached 700 degrees Celsius. This process would create a layer of oxide that isolates the layers below and facilitated the application of other layers on top of it. There were two types of ovens and each one was used depending on the material that needed to oxidize, the length of time, and amount of heat needed. The large oven could accommodate many wafers with different temperatures in each of its compartments over a longer period of time. The smaller ovens could only accommodate a single wafer at a time. The larger oven was used to heat up wafers coated with platinum.



## Cleaning Wafers

Another big part of the process required was cleaning the wafer, because we needed to remove any dust found to minimize testing error. It was a repetitive cycle between heating and cleaning, although the method of cleaning the wafers changed throughout the process. To clean the wafers after the first oven heating, they were placed in a glass wafer holding case and bathed in acid. Then they are placed over a hot plate until the acid boils in a chemical room. The hot plate gets really hot and we have to step outside the chemical room as a safety precaution. After several more



reheats in the oven, to clean the wafers all that was needed was to pour some acid on

the wafer and rinse with distilled water. Heating occurred rapidly in the ovens, but the cooling took at least an hour. Later in the process the wafers required less chemical cleaning.



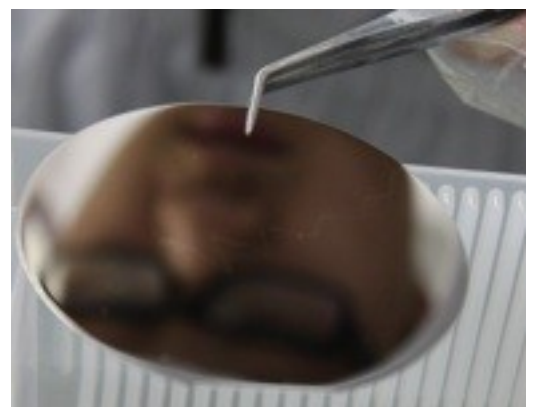
## Doping

Doping is the testing of layer consistency when a new layer is applied. A chemically cleaned wafer is placed in a spinning machine. (Shown on right)

This machine serves as a dryer and consistency tester. After the wafer is dried, we must check if the pattern from the chemical washing is uniform. If not, then the wafer must be washed again. The pattern must be uniform to reduce error and provide accurate testing when each part of the wafer is tested later on.



David Dai is seen checking for consistency on the right.

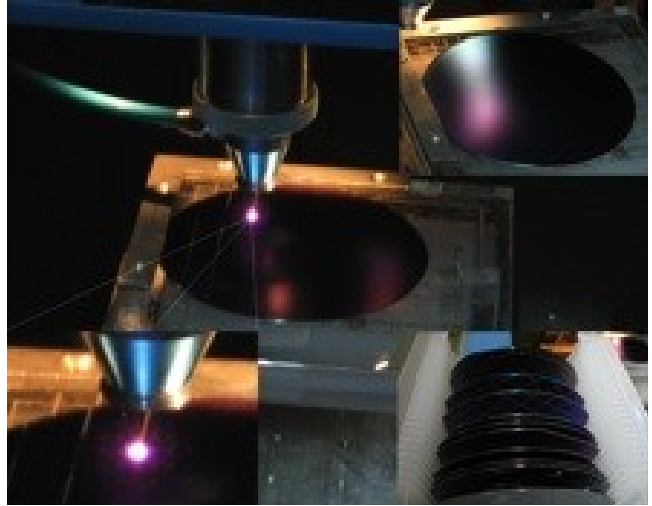


After a week of baking, washing, drying, and testing the silicon wafers for consistency, they are put into a big oven and coated with platinum.

David Dai is shown holding a silicon wafer coated with platinum fresh out of the large oven.

## Laser Cutting

Tsinghua University does not have a laser cutter of its own. Instead they must take the wafers, which they need cut, to an offsite facility that does have one. The site is located on the other side of town in the middle of the art district. The laser cutter is very impressive, and amazing to watch how light can cut through a piece of silicon. Feng, the host student, brought many wafers to cut that day, and all of them were cut into small squares. The laser does not completely cut the wafer into pieces. It cuts the wafer enough so that it still retains its circular shape and when a small force is applied onto the wafer we can snap off the necessary pieces.



## Software Testing

The production of a device on a silicon wafer is very expensive, but more importantly it is time consuming. Some stages of the process can take as little as 10 to 20 minutes, but others ranged from a few hours and others had to be left alone until the following afternoon. That is why we were introduced to a software simulator. ANSIS lets us simulate how a device will behave, or if it will work depending on the input data. This saves time and money because resources are optimized, and there is a better chance of getting accurate results. A few hours spent on the simulator can save days of work in the laboratory.

QuickTime<sup>®</sup> and a decompressor are needed to see this picture.

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## Soldering Wires to a Device

Once a device is made we must have a way for it to communicate and interact with the outside world. That is why when we design a device we must place contact pads. The pads are in the shape of tiny squares, and we soldered wires on to them using ultrasonic waves. The wires are so thin that it requires the use of a special machine that moves the wire for us. It also has a magnifying glass so we can see the wires and the pads. At Tsinghua University they also have an electronic microscope that allows them to solder even tinier wires and smaller pads. Even with the help of these specialized devices one must be extremely careful because the wires can break if too much tension is applied to them when soldering. It is a dreadful task to have to pass the thin wire from the spool of wire and reroute it much like a sewing machine, but with thinner and fragile wire. To solder we press a button when the tip is at the desired location. The tip comes down once, and in a split second comes right back up and the joint is soldered.



## Soldering Kits

We also had an opportunity to brush up on our soldering skills. We put together a small AM/FM radio that included both surface mount and traditional through-hole solder. The other kit was a battery charger, and it was more complex and had a lot of parts to it. The soldering kits are the same ones that the undergraduates use for practicing. These kits were fun, and helped us brush up on our soldering skills. The surface mount components were arranged in an assembly line fashion. Everyone had to keep moving along the chain finding the location of the component. This is similar to how it would be in an actual assembly line in a factory except we would be passing down a board and everyone would be specialized in placing a specific component on the board. When we were done placing components on a circuit board using solder paste, we gave our kits to a lab technician and they placed the circuit board in an oven. When they were done the solder had hardened and the



components looked very professionally assembled. The next step required us to physically solder the resistors and capacitors using a soldering iron. Finally everything was placed in its protective case and tested.

The battery charger was completely hole through solder. It was more challenging and it required all its components to fit snugly in its case. One of the drawbacks was the instruction manual was in Chinese and the pictures were a bit blurry and did not portray to much insight as to what the next step was. Luckily the host students helped us in each step that we would get stuck. Another problem was some kits had missing parts, and parts needed to be cannibalized from some of the host students' prior projects.



## **Conclusion**

The 2010 International Research Experience for Students sponsored by the National Science Foundation was a great success. We were able to conduct lab research in a field that each of the team members wishes to pursue when we earn our Bachelor's Degree and head towards graduate school. We were fortunate to experience international travel and Chinese culture. We learned many technical skills and developed teamwork skills that will become crucial in our future. We made many connections with the gracious host students and learned to work with other researchers of different backgrounds. We hope that this program continues so that future candidates can experience all the wonderful things we did and be even more driven to be the best in their field. Many of our experiences not detailed in this report can be found expressed in deep detail at [ee.ucr.edu/~ires](http://ee.ucr.edu/~ires). Although we are not able to fully express how much this opportunity meant to us, we were able to keep a daily blog of each day at the website mentioned in the last sentence. We are extremely appreciative of this opportunity sponsored by the National Science Foundation and deeply hope others can also experience this program.

