夏丰年老师一开始寒暄一下:

Xia: Hi Qian, happy new year. Where are you now, in your home?

Me: No,i’m in my hometown Yangzhou.

Xia: Oh, that’s quite close to my hometown, Wuxi.

Me: I think let me introduce my research experiences first.

Xia: Yeah, we can share your screen.

正文：

Me: Here is the list of my research experiences: At grade 4, in UBC, I studied Black Phosphorus using Raman Spectroscopy. At grade 3, I learned to synthesized 2-D materials Graphene/MoS2. At grade 2, every student in physics department was asked to design an experiment by ourselves. I re-designed the light path of Finel Hologram. And the top 3 work get published.

Xia: Are you from physics department?

Me: Yeah.

Xia: ok.

Me: At grade 1,2, I learned to design the Perovskite Solar cells. Let’s start from the Black Phosphorus. In the study of BP using 442nm Angular Resolved Raman Spectroscopy, We mainly solve two problems. First is to determine the crystal orientation of BP. Second is to find the relationship of Raman signal and the thickness of BP. We can get enough information from the title of this topic. Why we study BP? Because BP has excellent properties like tunable band gap and high electron mobility. How do we measure Angular Resolved Raman Spectroscopy. Here is the sketch map. We put the sample on the stage. The laser is incident on the sample and we collect the scattered light. We can rotate the sample to different angles and the intensity of the scattered light depends on the angle we rotate to. Finally, why we choose 442nm? Here are three Angular Resolved Raman Spectroscopy measured by three wavelengths, we can see that only the 442nm has a bow-tie shape, others are circles. And this bow-tie shape can show us the crystal orientation of BP.

Q1-----Xia: Can you explain why 442nm has a bow-tie shape?

Me: Do you mean how to theoretically calculate the Angular Resolved Raman Spectroscopy?

Xia: yeah.

Me: Of course, I prepared for it.

Xia: Ok, then briefly explain it.

Me: We know the phosphorus atom layer is on x-z plane. The coordinate here is for the convenience. The laser is incident in y direction ,so the incident electric field is polarized in x-z plane. We can rotate the sample around y-axis. The polarizer here is to filter out the scattered electric field that we are interested in.

Xia: Good, go ahead.

Me: So the big picture is, first we know the incident electric field, it’s from the laser we use. This incident electric field will induce dipoles in BP. You know, the incident electric field will separate the positive and negative charges, and this is dipoles. The dipoles will vibrate and re-radiate scattered electric field. Finally, we need to project the polarization of the scattered electric field to the polarization of the polarizer, do the inner product here.

Xia: Good.

Me: Then we can do some calculations. This is the dipole vector, Ei is the incident electric field vector. is the polarizibility tensor, we can measure it by experiments.(推导了一些公式)finally, this equation can explain the angular resolved Raman spetroscopy.

Q2---Xia: Yeah, you calculate the angular resolved Raman spectroscopy, but I don’t know what’s the difference of 442nm and other wavelengths.

Me: Oh, the polarizibility tensor is different if the wavelength is different.

Q3---Xia: Why?

Me: Polarizibility tensor describes how much the positive and negative charges can separate from each other. Different wavelengths of the laser will separate the positive and negative charges in different distances. So the polarizibility tensor is different if the wavelength is different.

Xia: Good, I get it. Go ahead.

Me: Then how does the Raman signal depends on the thickness of BP? The x-axis is the thickness of the BP, and the y-axis is the raman signal. We can see that the signal depends on the thickness of BP. It’s might be an easy to determine the thickness of BP. We attributed this phenomena to dimensional effect and heat effect. You know the band structure depends on the thickness of the BP. And Raman depends on the band structure, that’ the dimensional effect. Also, the laser can heat the BP up. Different thickness of BP will be heated up to different temperatures. And Raman depends on the temperature too. However, we didn’t do theoretical calculation here, we need to do more experiments.

Xia: No problem, that’s good.

Me: In order to understand the selection rules in Raman scattering, I also learned the Group theory by myself. The most important part is to understand the character table of group of Schrodinger equation in BP.( Group Theory夏老师没听懂) Do you have any questions?

Xia: Sorry, I haven’t learned Group theory, let’s go ahead.

Me: At grade 3, in my home university, I learned to synthesize 2-D materials Graphene/ MoS2. I adjusted the parameters like temperature, pressure to synthesize mono-layer Graphene/ MoS2. The Graphene is about 500um, the MoS2 is about 30um.

Q4---Xia: Is it single crystal?

Me: Yeah.

Xia: Good, that’s impressive.

Me: At grade 2, I redesigned the light path of Finel Hologram, I think it’s interesting. (夏老师无问题)

Xia: Good.

Me: At grade 1,2, I learned to design Perovskite Solar cells. I synthesized mono-dispersed TiO2 as the transportation layer. We need mono-dispersed because the surface is smooth so the photoelectric conversion layer contact with the TiO2 more efficiently.

Q5---Xia:What’s the structure of the Perovskite Solar cells?

Me: The photoelectric conversion layer is synthesized on TiO2. We use TiO2 because it’s transparent, so the photoelectric conversion layer can absorb light even though it’s below TiO2.

Q6---Xia: Ok, TiO2 is an insulator or it’s metallic? Does it have a band gap?

Me: Sorry, I didn’t know what’s band gap when i was just at grade 1,2. I just learned to synthesize it because it contact with photoelectric conversion layer efficiently.

Xia: You can look back about it.

Me: Let’s me think about it. Oh, I remembered how does it work. The energy level of TiO2 is a little lower than the photoelectric conversion layer’s. So the electron can drop from the energy level of the photoelectric conversion layer to the TiO2 transportation layer. Then electrons go to the electronics and go back to the photoelectric conversion layer. I think the electron moves in TiO2 transportation layer, so it’s metallic.

Xia: I understand it. Good.

Me: That’s all.

Xia: Happy new year again! Good bye.