„Learning by doing - a young traveler on the way“

Dai Zhang

My name is Dai Zhang and I am an “Akademische Rätin” at the Institute of Physical and Theoretical Chemistry, University Tübingen.

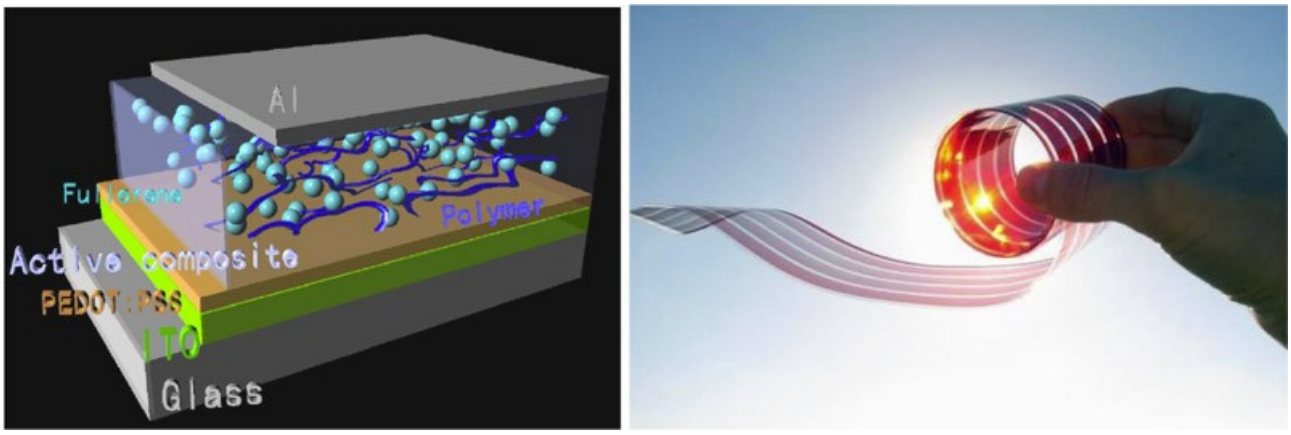
The family influence certainly played a major role in my choice for chemistry. My mother was a very enthusiastic college professor before she retired. She was utterly disappointed when she had to retire at the age of fifty-five. Even when I was a kid, she already tried to show me ‘magic tricks’ that actually based on simple chemical reactions. The curiosity for pursuing the reasons behind such ’magic’ was the most intriguing motivation for me to study chemistry. One of my favorite courses at the university was the lab course. I enjoyed it much more than just reciting equations from the text books. Certainly the ‘fun’ feeling sometimes turned to a bit ‘bitter’ when I ended up with zero amount of product after a whole day of organic synthesis…. On the other hand, this ‘pain and disappointment’ makes the success in lab course even more enjoyable and satisfactory, doesn’t it?

I always like research that is application-oriented. The main topic at my M. Sc. study was the electrochemical polymerization of monomers containing an aromatic ring on gold and glassy carbon electrode surfaces. I used these electropolymerized surfaces as chemical sensors to detect neurotransmitters such as dopamine and epinephrine; as well as pharmaceuticals such as dicynonum. During my PhD - study, I continued with the part of the work based on sensor; and furthermore, my interests moved to another application-oriented area: to improve the efficiency of new energy sources. My main work was to develop efficient anodic electrocatalysts for direct methanol fuel cells. Direct methanol fuel cells are promising alternative energy devices due to their advantages such as environmental friendliness, high-energy density, simple handling and benign operating conditions. Building high-performance fuel cell electrodes requires architectures that possess large surface areas as well as interconnecting channels allowing efficient molecular transport of reactants and products through catalysts. Considering these requirements, I synthesized silicon nanoparticles first, and then ‘assembled’ them into highly ordered ‘colloidal crystals’. Using these ‘colloidal crystals’ as templates, I fabricated three-dimensional ordered macroporous electrocatalysts nanocomposites allowing an optimized molecular transportation and a high surface area for the electrocatalysis.

During my work with direct methanol fuel cells, I noticed that my electrocatalysts had a rather satisfactory performance; however only for a short time. After long usage, the electrocatalyst surfaces were ‘poisoned’ by the adsorption of unwanted molecules at the active sites. In order to learn more about this problem, I changed my main research technique from electrochemistry to optics. I started to ‘look’ at monolayer molecule adsorbates, or even at single molecules, via a new technique: nanometer scale near-field optical microscopy. To learn such a technique, I made, so far, the biggest decision of my life: going to Germany. My first research position in Germany was offered to me by the department of physical chemistry that was directed by Prof. Gerhard Ertl (Nobel Prize Laureate 2007 in Chemistry), Fritz-Haber-Institut der Max-Planck-Gesellschaft. There I worked and further developed in a world-top-class scientific research group led by Dr. Bruno Pettinger. I benefited at the Fritz-Haber-Institute from a free and harmonic working atmosphere for students and young scientific researchers from all over the world. I

personally regard this as another essentially important factor beside the high-level research that attracts international scientists to participate and contribute to the German scientific development. Such positive experience is very impressive for an enthusiastic research-oriented youngster, which also fostered my decision of pursuing an academic career in Germany.

Besides investigating the 'poisoning' of electrocatalysts, I am also interested in improving organic solar cell efficiency. Nowadays, notable success in the conversion of solar energy to electricity has been achieved with silicon-wafer based photovoltaic cells. Despite this, researchers continue to search for more flexible, easy to manufacture, easy to mount, light weight, and low-cost photovoltaic alternatives. Plastic solar cells based on blends of conjugated polymers and fullerenes are the most promising candidates to meet these requirements. Organic bulk-heterojunction (BHJ) photovoltaic material was reported to have almost 100% internal quantum yield, leading to almost 8% power conversion efficiency. A sketch of a solar cell device is shown in the figure. In order to enter the market for integrated and roof-top photovoltaic panels, efficiencies above 10% are needed. Thus, progress is still required to reach this benchmark before commercialization can be realized. With the high-resolution near-field microscopic technique, I am able to distinguish the electron donor and acceptor materials at nanometer scale and to investigate the charge transfer at the interface with different nanoscopic techniques. Closely collaborating with industry partners, we are involved in selecting more efficient polymer candidates for maximum light-harvesting and in improving the stability of the solar cell modules. Realizing that my research is of interest for industrial applications, I feel that the direction of my research career becomes more and more clear. Wouldn't it be fantastic to see transparent plastic solar cell foils easily being fixed to the windows and producing electricity whenever the sun is shining? Or to use patches of light and flexible plastic solar cell foils to power up our cell phones or MP3-player while we are enjoying a lazy summer afternoon at the central park?



Figures 1 and 2: Left figure: Sandwich structure of a bulk-heterojunction plastic solar cell composing electron donor polymers and electron acceptor fullerenes. Al: cathode. ITO: indium tin oxide. PEDOT: PSS: poly(3,4-ethylenedioxythiophene)poly(styrenesulfonate). Figure taken from http://spie.org/x44511.xml?highlight=x2406. Right figure: Flexible and semi-transparent organic solar cell foils. Figure taken from http://www.enterprise.cam.ac.uk/media/thumbnails/resized/560x369/uploads/files/2/eight19-plastic-solar-cells.jpg.

At the time being, I am leading a group engaged in research on parabolic mirror assisted nanooptics. At the end of June of this year, I gave my lecture to qualify as a university lecturer 'Habilitationsvortrag' in chemistry. Shall I continue to pursue my career as a professor in chemistry? I am realistic enough to know that along this route I will not only face exciting opportunities, but may also have to tackle other problems as being a young, female and foreign scientist.

Nowadays in Europe there are many strategies to foster female researchers in the field of natural sciences. I observe the increasing support from local governments, research institutions, and funding agencies. They encourage women not only to initiate, but also to continue their scientific career in natural sciences. Sometimes my male colleagues even feel ‘gender-discriminated’. Why not take those opportunities of being a woman and to try to live our dreams? There are many ways to train us and to qualify for a career in science. Be independent, be confident, be positive and be strong - go out, build up networks, take responsibilities, share your experiences, it does not slow your pace down by taking time to reflect and to plan….be patient. Certainly, one of the most important things is professional qualification.

Sometimes when I look back, I am still able to remember myself as that young Chinese girl lost in woods in a dark night eight years ago in Berlin. She missed the bus stop because she could not understand the language, and she could not recognize the way as well since she was only a fresh-new ‘Berliner’. That anxiety was so strong that she started to doubt her decision of coming to this unfamiliar land thousands kilometers away from her warm home. Years later, when I received the honors from the Helene-Lange-Preis and the ADUC (Arbeitsgemeinschaft Deutscher Universitätsprofessoren und -professorinnen für Chemie)-Jahrespreis, when I handed in my Habilitationsschrift, when I stood at the stage of a full seminar room giving the Habilitationsvortrag, and when I took over the Habilitation certificate from the Dean’s office, my heart started to become quiet. I am so glad that I stayed, fought, and kept going. I feel like a traveler having started an exciting journey while learning by doing - step by step. I am glad to see that I am not alone on my way as I see more and more people joining me, walking along with me and encouraging me. “Wo ein Wille ist, ist auch ein Weg”.

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