CCS Chemistry Author Spotlight——新加坡国立大学 欧阳建勇教授

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人物介绍

Jianyong Ouyang （欧阳建勇）

Prof. Ouyang received his Ph.D., MS., and B.S. degreesfrom the Institute for Molecular Science in Japan, Institute of Chemistry,Chinese Academy of Science (ICCAS), and Tsinghua University in Beijing,respectively. He worked as an assistant professor at the Japanese AdvancedInstitute of Science and Technology and then a postdoctoral researcher at theUniversity of California, Los Angeles (UCLA) before joining the NationalUniversity of Singapore (NUS) as an assistant professor in 2006. His researchinterests include flexible and wearable electronics and energy materials anddevices. He invented the first polymer/nanoparticle memristor (2004), the firsthybrid ionic/electronic thermoelectric converter (2020), and the first adhesiveintrinsically conducting polymers (2020). Prof. Ouyang demonstrated the firstapplication of flexible strain sensors for food processing monitoring (2021),discovered the photon-enhanced Seebeck effect (2021), and continually reportedworld-record conductivities of solution-processable conducting poly andthermoelectric properties of polymers and ionic conductors.

Q1: Who helped you the most as you pursued your research career?

Prof. Ouyang: I received help from many people during my researchcareer. Among them, the person who helped me the most is Prof. Yongfang Li, mymaster’s degree supervisor, at the ICCAS. He taught me how to conduct research,such as designing experiments, analyzing results, preparing manuscripts andpresentations, and setting my research goals.

Q2: What are some difficult challenges you have faced during your research career? How did you overcome them?

Prof. Ouyang: I have met various challenges during my researchcareer. Among them are the enhancement in the Seebeck coefficient ofpoly(3,4-ethylenedioxythiophene): polystyrene sulfonate (PEDOT:PSS), which isthe most popular thermoelectric polymer, by ionic liquids. After my labdeveloped many novel methods to significantly enhance the conductivity ofPEDOT:PSS, I wanted to expand our research to high-performance thermoelectricpolymers. In addition to the enhancement in the conductivity, I wanted toenhance the Seebeck coefficient as well because thermoelectric polymersincluding PEDOT:PSS usually have a low Seebeck coefficient. However, themethods in the literature to enhance the Seebeck coefficient of PEDOT:PSS arenot very effective. We tried many new methods, but the enhancement in theoverall thermoelectric properties is not very large. After studying thethermoelectric properties of polymers and other materials, I proposed to enhancethe Seebeck coefficient of PEDOT:PSS by applying a coat of ionic liquid becauseionic liquids can have a high thermovoltage but low thermal conductivity. Thisidea was verified by our experiments and used to improve the overallthermoelectric properties of polymers to more than double the previous world record.

Q3: Who is(are) scientist(s) you most respect or admire? Why?

Prof. Ouyang: I admire the scientists who, instead of followingthe popular research directions, have their own vision of research, such as theinvention of transistors and mRNA vaccines. Their work can greatly advancescience and technology and improve our lives.

Q4: What do you see as the biggest obstacles and most promising applications in your research area?

Prof. Ouyang: One of my research areas is flexiblethermoelectrics. Flexible thermoelectric materials and devices have importantapplication in many areas, particularly in heat harvesting and cooling.Efficient heat harvesting is significant for sustainable development becauseheat is the primary energy source, and there is abundant waste heat on earth.Compared with the conventional cooling technology, thermoelectric coolingsystems can be much smaller and even portable. The application ofthermoelectric generators and cooling devices can be greatly expanded by usingflexible thermoelectric materials. However, the thermoelectric properties ofthe flexible materials including polymers, polymer composites, and ionicconductors must be saliently improved for these applications. This requires collaborationsfrom many fields such as chemistry, physics, and materials science andengineering.

Q5: What advice do you have for younger students and researchers beginning their careers in chemistry, and in particular those interested in your field?

Prof. Ouyang: My advice for younger students and researchers is todo novel research and make original contributions. They should formulateresearch ideas to solve important problems in the fundamental understanding ofscience. Do not waste time on simply repeating the research of other people.

Q6: Thank you for publishing your superb work in CCS Chemistry! Could you provide a brief summary of your article and current research direction in a few sentences?

Prof. Ouyang: This articleis a review of the enhancement in the Seebeck coefficient of organicthermoelectric materials by energy filtering. A high Seebeck coefficient isrequired for thermoelectric materials. However, thermoelectric polymers usuallyexhibit an order of magnitude lower Seebeck coefficient than their inorganiccounterpart. Although the Seebeck coefficient can be improved by dedoping, theconductivity is sacrificed. Energy filtering can improve the Seebeckcoefficient of inorganic and organic thermoelectric materials, but it does not significantlylower the conductivity. In this article, we start from the fundamentalknowledge of thermoelectrics and energy filtering. Then, the energy filteringmethods for thermoelectric polymers are reviewed.

Like inorganic thermoelectric materials, energy filtering can greatlyimprove the Seebeck coefficient and thus the overall thermoelectric propertiesof polymers. Energy filtering methods different from those for inorganicthermoelectric materials should be developed for flexible thermoelectricmaterials. The energy filtering of polymers can be achieved through theincorporation of a second species like electronic materials, ions, or moleculesinto the thermoelectric polymers. In addition, the second species can be directlybonded to the thermoelectric polymers through chemical modification.

Learn more: Xin Guan and JianyongOuyang*(欧阳建勇). **Enhancement of theSeebeck Coefficient of Organic Thermoelectric Materials via Energy Filtering**

ofCharge Carriers. CCS Chem. 2021, **3**, 2415–2427.

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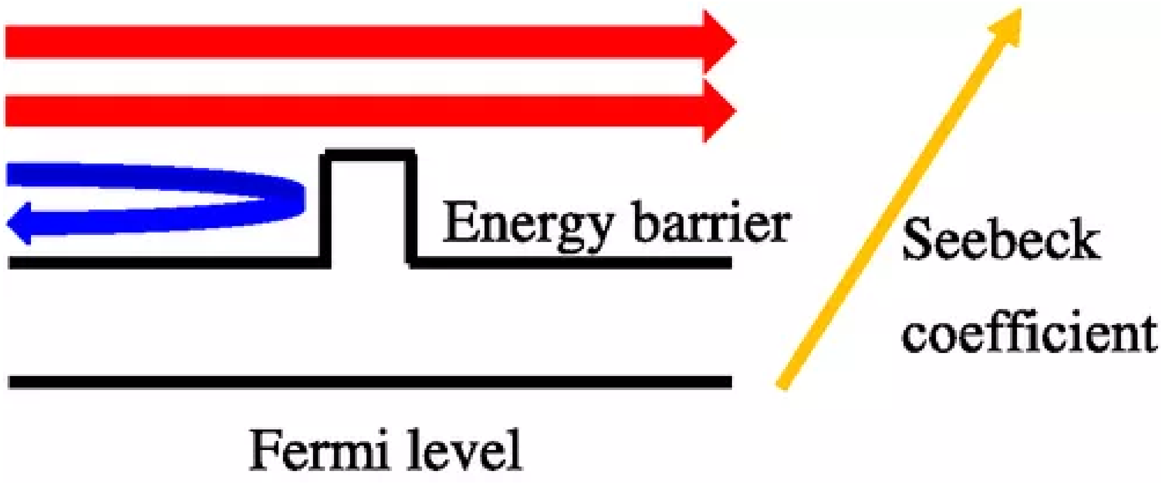

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