Chenyu Yan

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Education Background

I received BS degree with Electrical Engineering and Automation (GPA: 3.7, 10%) from Northwestern Polytechnical University(NPU), People Republic of China(PRC), in June 2016 and the topic of thesis is "Design of large scale Lithium-ion battery stack management system based on ARM". I received MS degree with Electrical Engineering (GPA: 3.7, 5%) from Xi'an Jiaotong University(XJTU), PRC, in June 2019 and the topic of thesis is "Research on Electrical Breakdown Property of Polypropylene Nanocomposite Dielectric Modulated by Charge Transport and Molecular Displacement". At present, I'm enrolled in Master of Science in Computer Science Degree provided by Georgia Institute of Technology (Gatech, USA).

During postgraduate's study, I was in Prof. Shengtao Li's group and my research focused on, power equipment, high voltage electric transmission and charge transport modeling, numerical algorithm and calculation. In past 3 years, I have a relatively good understanding of energy storage, nanocomposite fabrication, characterization and testing, charge/carrier transport modeling, numerical algorithm and calculation for nanocomposite dielectric. Different from extensive researches regarding how to enhance electrical strength via doping and composing, I chose to investigate the internal mechanism and explain why methods like doping or composing has impact on electrical breakdown behavior of dielectrics. Under my prof. Daomin Min's guidance, I gradually formulated ability to deal with scholar research and got a deeper insight towards my study. **During this period, I was involved in 3 national projects and had 16 papers published**.

Publications

My Research Gate

1. Min DM, **Yan CY**, Huang Y, et.al. Dielectric and carrier transport properties of silicone rubber degraded by gamma irradiation[J]. Polymers, 2016, 9(10): 1-15 (SCI:

000414913800071; EI: 20174304306504)
2. Min DM, **Yan CY**, Mi R, et.al. Carrier Transport and Molecular Displacement Modulated dc Electrical Breakdown of Polypropylene Nanocomposites[J]. Polymers, 2018, 10(11): 1-20 (SCI: 000454456800029; EI: 20184606058526)
3. Min DM, Li YW, **Yan CY**, et.al. Thickness Dependent dc Electrical Breakdown of Polyimide Modulated by Charge Transport and Molecular Displacement[J], 2018, Polymers, 10(9): 1-18 (SCI: 000449988800081; EI: 20183805840118)
4. Min DM, **Yan CY**, Wang WW, et al. Electrical breakdown of polymer nanocomposites modulated by space charges[C]. IEEE 17th International Conference on Nanotechnology, 2017: 267-269 (EI: 20180604700270)
5. Xie DR, **Yan CY**, Huang Y, et al. Study on short-term dc breakdown and corona resistance mechanism of polyimide. Proceedings of 2017 International Symposium on Electrical Insulating Materials, 2017: 437-441 (EI: 20180704798615)
6. Kang WB, **Yan CY**, Li ST, et al. Trap and carrier transport of pristine and aged silicone rubber by surface potential measurements[C]. Proceedings of 2017 International Symposium on Electrical Insulating Materials, 2017: 207-210 (EI: 20180704798674)**
7. Li SJ, Yan W, **Yan CY**, et al. Surface trap and carrier transport of aged and pristine oil-paper under harmonic voltage by surface potential decay[C]. IEEE Conference on Electrical Insulation and Dielectric Phenomenon, 2017: 94-97 (EI: 20181505007629)
8. Cheng L, Chi XH, **Yan CY**, et al. Polypropylene nanocomposite for power equipment: a review[J]. IET Nanodielectrics, 2018, 1(2): 92-103
9. Min DM, **Yan CY**, Huang Y, et.al. Influence of filler content on conductivity of epoxy resin nanocomposites[C]. The 20th International Symposium on High Voltage Engineering, 2017: 1-6
10. Min DM, **Yan CY**, Mi R, et al. Space-charge modulated electrical breakdown in polyethylene nanodielelctrics[J]. IEEE Nanotechnology Magazine, 12(2): 15-22.
11. Mi R, **Yan CY**, Wu QZ, Min DM, Li ST. Effect of deep traps and molecular motion on dc breakdown of polyethylene nanocomposites[C]. IEEE Conference on Electrical Insulation and Dielectric Phenomenon 2019
12. Li YW, **Yan CY**, Min DM, Li ST. Numerical simulation on dc breakdown of polyimide based on charge transport and molecular chain displacement[C]. IEEE Conference on Electrical Insulation and Dielectric Phenomenon 2019
13. Kang WB, Meng SX, Cui HZ, Li YW, Mi R, **Yan CY**, Min DM, Li ST. Space charge accumulation in silicone rubber influenced by Poole-Frenkel effect[C]. International Conference on novel functional materials, 2018: 1-5 (EI: 20185306321507)
14. Cui HZ, Xing ZL, Wu QZ, **Yan CY**, Mi R, Min DM, and Li ST. Accumulation of space charges in epoxy resin nanodielectrics influenced by Poole-Frenkel effect, International Conference on novel functional materials 2019
15. Kang WB, Meng SX, Cui HZ, **Yan CY**, Min DM, Li ST. Trap and dielectric property evolution of silicone rubber insulation under power frequency voltage superimposed harmonic [J]. High voltage (Chinese)

- **Min DM is my professor during graduated study and gave lots of assistance to my research, in all these work, I was responsible for experiment design, operation, analysis and paper writing.**

Scholarship

1. National Scholarship 2018.11 & 2017.11
2. First class scholarship 2018.11 & 2017.11
3. Scholarship for excellent freshman 2016.09
4. Provincial special scholarship 2015.09
5. First class scholarship 2015.09 & 2014.09 & 2013.09
6. E+H special scholarship 2014.09

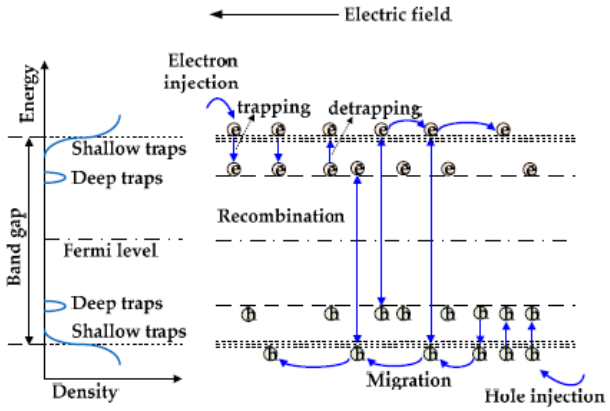
Awards

1. Outstanding graduated student 2019.06
2. Merit master student award 2018.11 & 2017.11
3. National Mathematical Contest in Modeling for Graduated students, Honorable mention 2017.11
4. Outstanding graduated student 2016.06
5. The 5th session of MathorCup Mathematical Contest in Modeling, Outstanding award 2015.06
6. College Students' Innovative Entrepreneurial Training Plan Program, three projects in 2015 and 2014
7. International Mathematical Contest in Modeling (MCM), Honorable mention 2015.03
8. National Mathematical Contest in Modeling, Outstanding award 2014.11
9. Best debater in debate competition in China 2014.10
10. Excellent world teenager in Japan, Korea and China forum 2014.09
11. Merit student award 2015.11 & 2014.11 & 2013.11

Highlights of research

Carrier Transport and Molecular Displacement Modulated (CTMD) model

This model considers the charge injection, migration, trapping/detrapping and recombination dynamic process and depicts the continuous motion process of charges in the bulk of dielectrics.



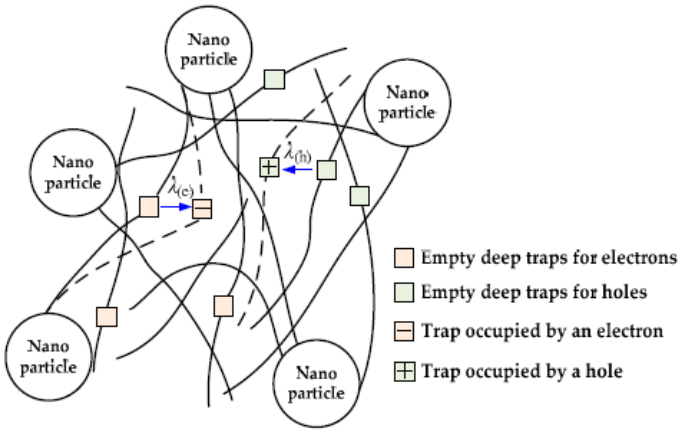


Fig. Scheme of CTMD model and molecular chain displacement model

Charges are continuously injected from electrodes to the bulk of samples and they may be captured by traps (both shallow traps and deep ones). When captured by deep traps, which means charges need to obtain higher energy to detrap, charge keep retention for a longer period. Also, during the migration from one electrode to another one, combination may occur when a positive charge encounters a negative one. Such a dynamic process includes entire charge motion process. By setting boundaries of model and solving Poisson's equation, this model can be used for calculating the charge transport property in the bulk of insulating material, including numerical calculation of space charge and electrical field distribution, energy gained by electrons as well as electrical strength. This model was once used for explaining the electrical breakdown behavior of polypropylene (PP, used for film of power capacitor) nanocomposite. By combining the experimental results and calculation of model, hidden electrical breakdown mechanism of PP nanocomposite was revealed. Details regarding the model can be seen in Carrier Transport and Molecular Displacement Modulated dc Electrical Breakdown of Polypropylene Nanocomposites.

Based on this model, we investigate the electrical breakdown property of PI samples with various thicknesses. It is found that similar mechanism modulates the breakdown behavior of PI and simulations results are better fit than the space charge electrical breakdown (SCEB) model. We also find similarity and differences of breakdown mechanism of various dielectric materials. Relating results and comparison can be found in Thickness-Dependent DC Electrical Breakdown of Polyimide Modulated by Charge Transport and Molecular Displacement.

This model can further be applied to the charge transport in other systems, not limiting to insulation material system, since regularity of charge behavior exists in any system with external electrical field applied. Currently, in our research group, this model is also modified and utilized in field of ultra high thermal conductivity and carrier migration in solid battery. In the future, it is promising to combine this model of machine learning to determine more accurate probability of charge behavior so that it can more closely reveal the charge migration property in the system, Also, the dimension of charge transport can be extended to 3D to show a tridimensional picture of its motion property.

Dielectric property simulation of insulating material

Method of modeling on dielectric property of aging Silicone Rubber is proposed. Specifically, by fitting the spectra to theoretical equations, we separated different polarization processes at various frequencies and calculated the values of corresponding parameters like thermal expansion coefficient, swelling ratio, etc.. By utilizing the correlations among various parameters, polarization property and specific process of SiR was delineated. Additionally, paper investigated the influence of degradation on the

dielectric constant at high frequencies, ion concentration, conductivity and trap distribution, illustrating the charge transport property in the bulk of SiR and revealed the hidden cause for polarization. More information can be seen in Dielectric and Carrier Transport Properties of Silicone Rubber Degraded by Gamma Irradiation

For your information, more my published papers can be found in:

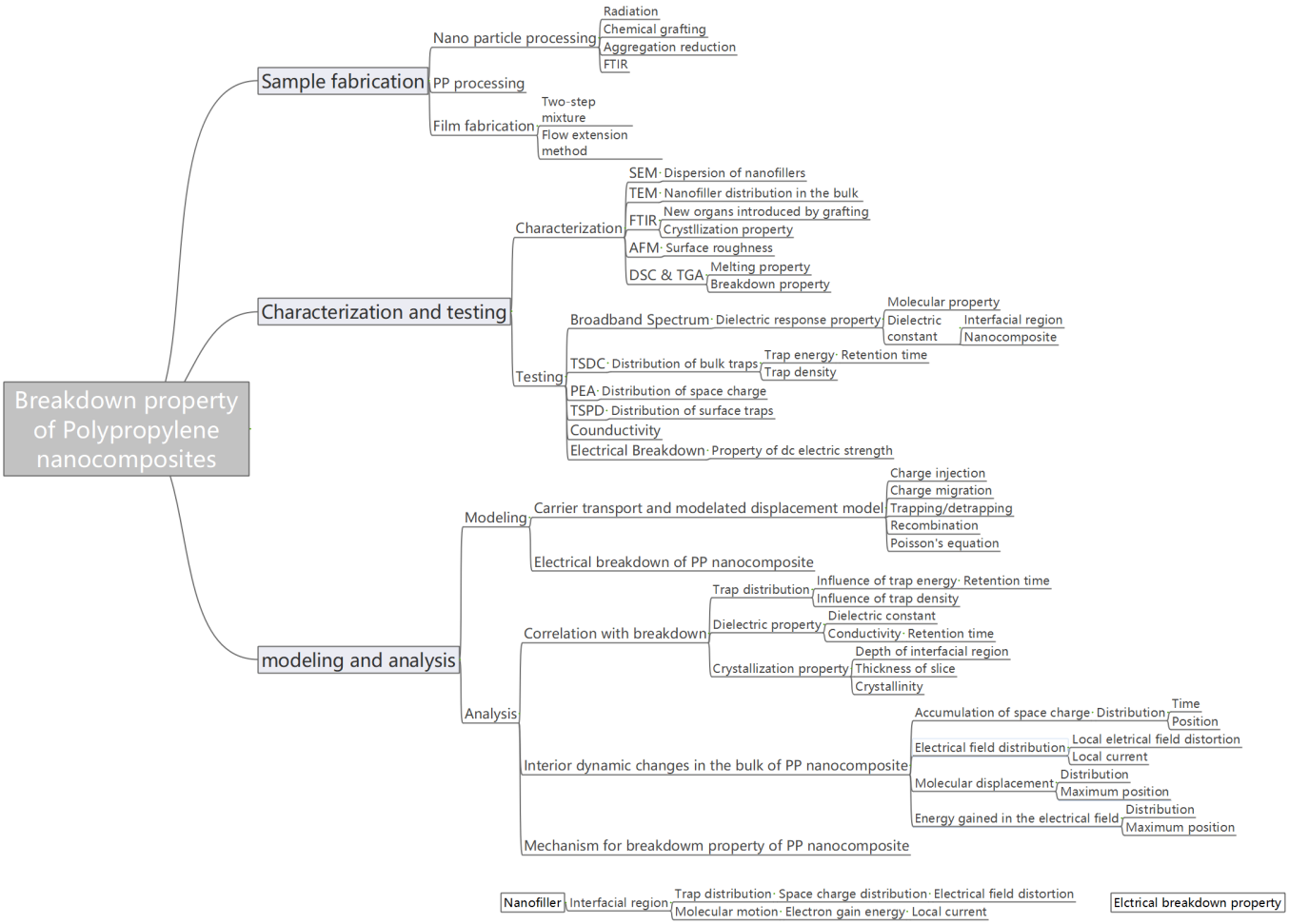
- Electrical breakdown of polymer nanocomposites modulated by space charges
- Study on short-term dc breakdown and corona resistance mechanism of polyimide
- Trap and carrier transport of pristine and aged silicone rubber by surface potential measurements
- Surface trap and carrier transport of aged and pristine oil-paper under harmonic voltage by surface potential decay
- Polypropylene nanocomposite for power equipment: a review
- Space-charge modulated electrical breakdown in polyethylene nanodielelctrics
- Effect of deep traps and molecular motion on dc breakdown of polyethylene nanocomposites
- Numerical simulation on dc breakdown of polyimide based on charge transport and molecular chain displacement
- Space charge accumulation in silicone rubber influenced by Poole-Frenkel effect
- Accumulation of space charges in epoxy resin nanodielectrics influenced by Poole-Frenkel effect
- Dielectric properties of aged and pristine oil-paper under harmonic voltage by frequency domain spectroscopy

Thesis paper

Title of my thesis paper is "Research on Electrical Breakdown Property of Polypropylene Nanocomposite Dielectric Modulated by Charge Transport and Molecular Displacement". By combining the experimental results and modeling calculation results, the thesis proposes an explanation for demonstrating the mechanism of electrical breakdown property of PP/Al_2O_3 nanocomposite.

Overview on structure

Entire research of thesis includes sample fabrication, characterization and testing as well as modeling and analysis, shown as the graph below.



Summary of results

It is worth mentioning that, based on the summary of current synthetise method of nanocomposite, the thesis employed a new fabrication method to prepare samples, which turns out that fillers homogeneously dispersed and both stability and dielectric property were enhanced compared with former results that employed original method.

The thesis correlates the characterization and testing results, namely morphology, thermal, crystallization property and polarization, trap distribution, electrical strength, conductivity property. After analyzing the correlations among different property of samples, it was concluded that trap distribution has a main effect on electrical breakdown property of PP/Al_2O_3 nanocomposite.

By comparing previous analysis and simulation results with the CTMD model, mechanism of PP/Al_2O_3 nanocomposite has been revealed. It turns that nanofiller introduced interfacial regions to the neat material. Therefore, trap distribution in the bulk of material is altered, leading to the changes in distribution of space charge and electrical field distribution. Also, due to the occupation effect of charges in the traps, molecular motion may be impeded , leading to an increase in energy gained by electrons and spur of local current. Such a coordination process results the electrical breakdown property of nanocomposites. Results of thesis well explained the reasons for electrical breakdown property enhancement, which is significant for further study on modulating

electrical strength even other electrical properties of nanocomposites.

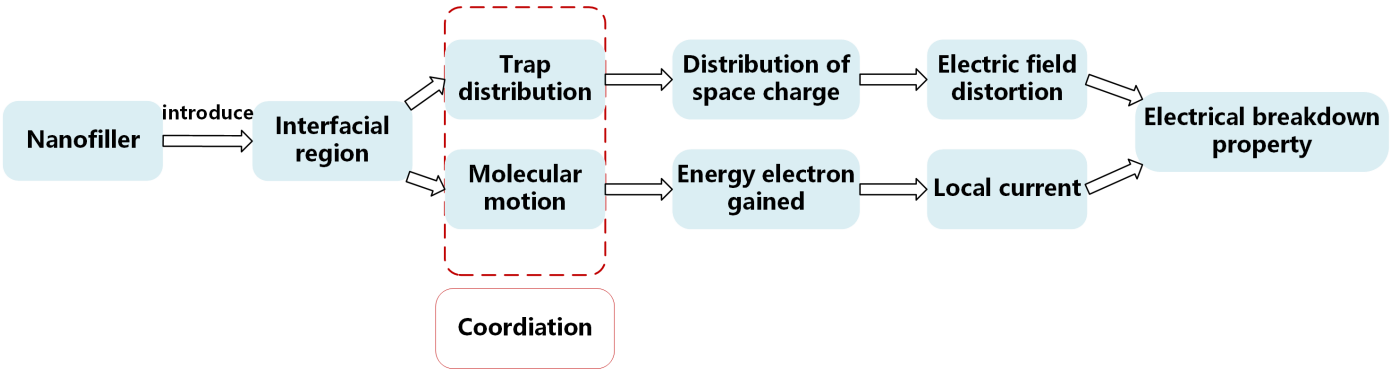


Fig. Mechanism of electrical breakdown process of PP nanocomposite

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Project Experience

- **Influence of molecular chain motion property in interfacial regions on dc breakdown property of polyethylene nanocomposites (National Natural Science Foundation of China)**

N S F C
National Natural Science Foundation of China

This project was originated from the need for enhancing breakdown property of polyethylene to meet up with its demand for high voltage power transmission. Based on the motion property of molecular chains at the interfacial regions, this study investigated its impact on dc breakdown property of polyethylene nanocomposites and revealed the mechanism of nanocomposite breakdown. I'm responsible for experiments progress and paper writing (academic paper and project report).

- **Insulating property and its regularity of dielectrics in current transfer and energy dissipation (National Key Basic Research Program (973) sub-project)**

This project investigated the coupling impact of space charge accumulation, transient arc micro particle bombardment, metal particle deposition on the falshover property of fractrue insulating system in the process of dc arc switching, and revealed its influence regularity and failure mechanism. Based on nanocomposition modification tech, study figured out the the methods to suppress the space charge accumulation and metal particle deposition in the fracture insulating system and proposed approaches to resist flashover damage and aging. This research provided the theoretical and technology support for enhancing the voltage, current as well as lifespan of circuit breaker. I was mainly involved in the modeling of energy accumulation and flashover process, and investigated the influence of charge transport parameters and temperature on flashover behavior.

- **Charge transport property in silicone rubber under harmonic aging (Project of China Electric Power Research Institute)**

This project was originated from the need that power equipment like cable and bush are easier to be aged under the high-order harmonics, which hence deteriorated the performance of power system. The study, taking the silicon rubber from the outer coat of cable terminals and the insulating oil paper in the bush as the research objects, quantificationally manifested the aging status and summarized the insulating material deterioration regularity. In addition, aging model for cable and bush were proposed to predict their odd lifespans and the mechanism of aging have been demonstrated. I was responsible for experiment design, experiment accomplishment, modeling calculation and paper writing.

Work Experience and Internship

State Grid Corporation of China Department of Information and Internet 2019.09 - Now

I worked in State Grid Corporation of China (SGCC), known as the largest corporation in China, for half a year. In this period, I worked as a member in Department of Information and Internet, which focuses on data collection and processing to propose practical suggestions for the development of corporation. I have been involved in a project to predict short-term load of grid power, including day load forecast and workload forecast. This work aimed at suppressing illegal electric larceny especially in corporation with relatively higher demand for electric resources, so that the lost profits can be reclaimed and SGCC also has a greater power to better distribute the power transmission. In this project, I was responsible for forecast modeling and data processing, which provided the basis of prediction. Specifically, with the previous data of electric usage as the input, we built up architecture based on RNN and LSTM model to forecast the electric demand for following 7 days. By comparing with realistic values, it was proved that model had a relatively high precision and value of MAPE was around 2.4%. This project has been recognized as one of the most important projects for 2019-2020. In addition, we are currently focusing on the build of central data platform, which can help to fully utilize numerous data resources to run the company more efficiently and yield more profits, for instance,

Also, we built a central platform, collaborating with Alibaba, to collect all data from power grid system to help making decision regarding equipment maintenance, power distribution and redistribution, dispatching and monitoring. For example, a serious problem of vehicle charging is occupation of space, which means some customers complete charging with vehicles immobile, aggravating the limited usage originated from insufficient charging piles. In this regard, we optimize the power supply of electricity power and get customer notified when the charging if finished to make full use of charging piles and guarantee most customers can utilize devices. Also, data generated by routine experiment and maintenance of power equipments, data monitoring of charging expenditure (wave crest and peak) and status of device parameter including insulating oil temperature, switch motion, harmonic wave, etc. are also collected to formulate dynamic process, increasing efficiency and effectiveness of electrical test and repairing.

Asea Brown Boveri Ltd., China Electrical Engineer Internship 2016.05-2016.09

I was a internship of technology department in ABB for four months. During this period, I have the initial understanding of industrialization of power system, especially the power capacitor. With an increase in familiarity with equipment, I have a more lucid concept for structure of power system and commercial market in this field. Plus, with the support of

investigation in the equipment workshop, I learned the processing flow of capacitor, starting from the polypropylene film fabrication to the component assembly. In addition, I also got an opportunity to be engaged in the technical discussion with foreign experts, which largely bring inspiration to my further exploration on the research. Through intensive discussion, I found that increasing demand for high voltage transmission had been an urgent need for the grids in China, property of electric breakdown, however, was a key factor that determined the performance of power capacity. Therefore, when choosing the major field in my master phase, I forwardly approached to my professor and expressed my plan on the research of breakdown property of polypropylene. One more thing, it is worth being mentioned that I developed a program based on C++ during my internship to help collecting documents to meet the needs of engineers, which has been integrated to the system of ABB and used until now.

Personal Statement

I have a good mathematical modeling and programming basis for developing scholar research. I have ever participated Mathematical Contest in Modeling and obtained international/national award for 7 times, such an experience gave me the basic understanding of modeling. When facing with following modeling and calculation work, like charge transport modeling and lifespan prediction, I can better handle it and tried to proposed new methods to solve problems. Also, I can employ Python, SPSS, MATLAB to support my research work, charge transport model proposed in my published work is compiled by MATLAB. Plus, I'm enrolling in the study of machine learning and data science in Coursera to have a systematic study and make preparation for following work.

I have an positive attitude towards scholar research and good ability to achieve goals, which are important quality for a Ph.D candidate. I intend to do research work in future (either industrial or academic), since I find it so interesting to solve out the puzzlement and propel the implementation of my research field, such a sense of achievement is hard to get via other ways. Furthermore, I have a relatively good knowledge accumulation of my research field, including experiment design, data processing and paper writing, which guarantees my promising yields on the way of achieving Ph.D. I can well cooperate with mates and professors. In my perspective, relationship between professor and students is not dedication and obey, but discussion and mutual inspiration. Specifically, I need to regularly discuss my ideas on research with professor and seek for more novel ideas, however, I should have a lucid scheme for my work rather than relying on professor's order. Actually, I did well in past three years, like I always make full preparation prior to discussing with my professor on some key problems to enhance our communication efficiency and I also proposed my own ideas on some cardinal points. After discussion, I immediately conclude results and try to modify or consummate my research methods.

In addition, I am a good learner for new challenges and I like to combine theoretical analysis with practical application. It is inevitable that numerous unexpected problems can arouse during study and academic research, as far as I'm concerned, I enjoy solving problems and obtained new skills. For instance, when I started to participate in MCM, I got familiar with new models every time when facing new questions. Also, it is my initial experience for numerical calculation, like Genetic Algorithm, greedy algorithm, Dynamic Programming, etc., and formal paper writing, like structure, format, details and demonstration skills, which really paves the way for my following research. I firmly believe that I can do more and better once I decide to make it.