

## Research Internship Report

### Research Activity in Evonik Industries and Life in Germany

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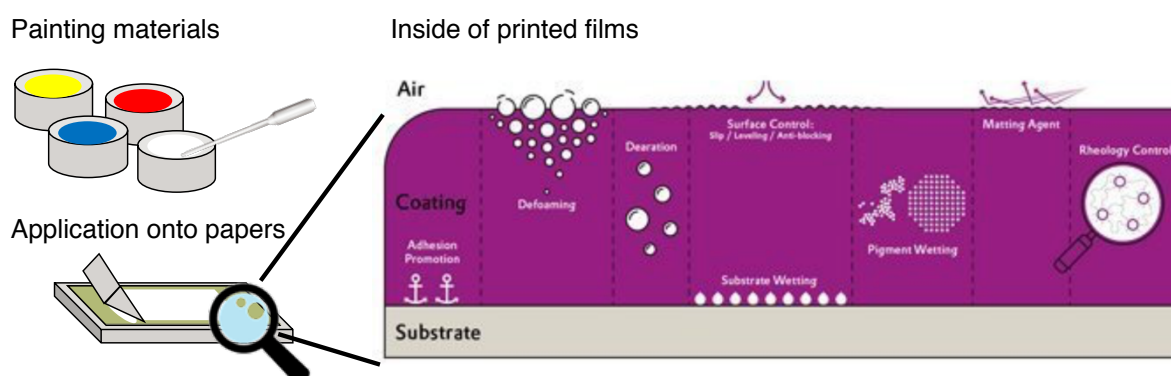
#### 1. インターンシップの概要(Outline of internship)

My internship program was supported by Evonik Industries AG(Essen, Germany) from May 20th to August 16th, 2019. Through this internship, I studied at Decorative Inks and Projects EMEA team, Coating & Additives, Evonik Resource Efficiency GmbH under Mr. Thorsten Schierle, my supervisor.

Initially, I attended the internship orientation of GMSI program to find a program fulfilling following three aspects. 1) Experience work and life in foreign countries during my PhD course to broaden my mind 2) Test my knowledge and logical thinking in industry field 3) Experience how chemistry contributes to society in engineering aspects. Among a list of internship programs, Evonik's attracted me for that the internship look to contain above three points, and it is a world leading company in the field of interface and colloid science, which is relating to my research in PhD course. In such an aspect, it was also important that the internships gave me a chance to discuss and find the research topics with organizer to make the internship activity more efficiently.

#### 2. インターンシップテーマと成果(What did you do this internship?)

I worked to develop new printing materials for wall paper used for decorating house. Those printing materials, including inks, were made of pigments, which is organic/inorganic nanoparticles dispersing in solvent, not like a solubilized dye. Evonik has well-developed techniques and a huge variety of silica nanoparticles, silicone oils and other related materials giving special properties for printing materials. These products play a lot of roles in the dispersion, such as pigment, functional nanomaterial, defoamer, wax and etc.



**Figure. Schematic illustration how coating additives work in printing material.** Retrieved on Aug 5th, 2019, from *Evonik Industries AG*. <https://corporate.evonik.de/en/pages/article.aspx?articleId=342>

In this program, I mainly focused on applying specific silica nanoparticles, which are originally developed for other fields such as health care, into printing ink fields to find out and utilize their new properties as matting agents.

Generally, the matting effect could be achieved by making irregular surface of printed films to reflect an incident light randomly. The irregular surface was prepared with the combination of binders (polymer gel) and matting agents (here, silica nanoparticles) by evaporating solvents on substrates. To achieve such a behavior, the printing material dispersions should be designed to possess various properties; dispersion stability, appropriate viscosity, adhesive property, etc.

Thus, for applying new nanoparticles as a first trial in the research group, I prepared their dispersions by mixing 5 to 9 materials step-wisely, with checking the characters of dispersions and films prepared by them. Subsequently, the properties were compared with those of other matting agents, and deduced their effect on homogeneity (compatibility), matting effect and scratching resistance from particle size, morphology, surface-coating, film thickness and etc. Finally, I got the painting materials showing good matting effect and scratch resistance by using the new silica nanoparticles mentioned above as matting agents and summarized a general rule of matting effect among various matting agents and other additives.

During this internship, I got a chance to attend a meeting with companies producing raw materials and to experience lab-tour of production lines of polyvinylchloride (PVC) materials. This experience gave me insights how the printing materials are applied to produce beautiful pictures, and it surprised me that the design and process to produce not only 2D but also 3D prints.

The laboratory is located in the building where the other groups relating printing works together, and I also learned a various technique there. Especially, table-top SEM, for characterizing nanomaterials structures and the surface of produced film, attracted me a lot. The technique has large difference with that of SEM I used in my PhD course, and it motivate me and broaden my mind.

### **3. 感想(Your comment of internship)**

When I applied this internship program, I can speak English applicable for daily life and research activity, but I cannot speak German language. Thus, after arriving at Germany and noticing that 99% of my colleagues speak German, I thought that my internship would be super difficult. In terms of office procedures and researches, half of people spoke me in English, and I could do it smoothly by myself. However, the daily conversation in lab., of course, people speak German, so I tried to learn German hard by listening their meanings and intonations. By hearing the experiences of my friends who studied at German universities or Max Plank Institute, there are lot of foreigners, and people speak English a lot. Thus, such a language environment is one of the big differences between internship program and studying abroad.

Through this internship, I could feel a real work and life in German due to above aspects. It was a precious experience for my life, and I was really satisfied with the program supplied by Evonik Industries AG.