

Ichiban Everything!



Imee Su Martinez, Ph.D.

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ismartinez@up.edu.ph

From world-class “ichiban” research facilities, to world heritage sites, and affordable Michelin star cuisine, a visiting researcher fellowship in Japan has always been a sought-after experience. My very own journey as a researcher brought me to Kyoto University in Uji Campus. I was having a grade A problem with some materials called molecularly imprinted polymers (MIP) that when an email in my university circulated that a JSPS (Japan Society for the Promotion of Science) Program called KAPLAT was offering a one-month fellowship, I decided to apply right away. I just knew that I needed state-of-the-art equipment to solve this problem, and the best people to help me solve it. I was very lucky of course to get accepted, and to be given the opportunity to work with the best in their fields, in my case a free-electron laser (FEL) world-class (another ichiban!) expert Prof. Hideaki Ohgaki. My very first day on campus, I knew right away, I came to the right place when I saw my *Sensei* in a suit and worn out sneakers. There is always this tangible sense of humility with people who are really good at what they do. It is as if, they have been whispered tidbits of secrets of the universe, and they are somehow wiser than most of us. I was told right away that one month is too short, of course, but it is a good time to explore and test possible solutions.

My first week was spent taking online examinations on radiation safety and web security, so I would be able to work inside the campus. I also had to present the research problem I brought with me seeking guidance from more seasoned researchers on how to go about my research plan. You see these MIPs are defined as “man-made polymer mimics of the natural antibody-antigen system” or lock-and key mechanism to selectively bind and detect molecules “templated” into their polymer matrix.¹ They have three well-known limitations when used as sensing

materials, and these are incomplete template molecule removal, non-specific analyte binding, and non-homogeneous binding sites resulting in various values of rebinding constants. Our recent paper through surface analyses had shown the difficulty of template removal by washing the MIP with various solvents.² This was the key problem I had presented to my *Sensei* and his group, and they decided to subject the MIPs that I had brought with me to the FEL at specific wavenumbers pertaining to vibrational modes of certain functional groups in the template molecule. The goal was to break the bonds within this moiety or to totally remove this functional group using free electrons marching forward at a specific tempo or frequency, in the hope of finding an alternative way of removing these template molecules entirely. An interesting theory to solve the template removal problem, worthy of a test run!

One weekend, I was in one of the major tourist attractions in Kyoto, the Fushimi Inari, trekking up the Inari Mountain. This is a shrine to Inari, the “kami” of rice and agriculture, and patron of business.^{3,4} Rows and rows of majestic fire engine red *torii* lined the steps of the shrine, guiding the way, as if beckoning pilgrims to follow their dreams. Apparently, to donate a *torii* is supposed to grant every wish your heart desires. It was during the Edo period that this tradition was popularized, as early as the 15th century. So, I bought my very own refrigerator magnet *torii*, prayed a bit, and also got lost a bit. I looked at one of the maps strategically placed in the shrine, the one placed near a quaint little teahouse to find my way, when I realized that the path actually goes in a circle. In fact, certain spots were designated as irregular four-sided parallelograms going round and round. It looked to me as if these rectangles were spin coated around the

mountain, yet no matter how precise they wanted the pattern to be, these areas seem to have a mind of their own. They disperse themselves of their own volition! These made me think of my MIPs, which were spin coated to create the polymer films. The template molecules, although they were meant to disperse uniformly throughout the film, will always behave according to their structure, depending on their affinity to the other components of the MIP, whether to the polymer matrix or to other compounds such as the porogen. The limitations of the MIPs stated in every article written about them are just inevitable outcomes of the physical characteristics of these films such as non-uniform template dispersion, and inhomogenous polymer morphology, whether in its matrix or at the surface. These features lead to difficulty in template removal, as some template molecules get entrenched into the complex weaving of the polymer matrix. The template molecules during MIP preparation are dispersed heterogeneously, sometimes aggregating, creating cavities of various shapes and forms, and if they tend to be attracted to the porogen, this leads to different shapes, deviating from the lock and key system. This then leads to non-selectivity during rebinding and different binding constants. And if this can be proven spectroscopically, then life can sometimes be a fulfilled wish, especially to a lost researcher trekking around and around Inariyama!

So just like my pilgrimage in Fushimi Inari, my MIP journey comes to full circle. Having a theory of how the MIP is formed, and to be able to prove this through experimentation using spectroscopy or microscopy, is already a sign of moving in the right direction. However, just like what my *Sensei* said, my stay is too short, and so it was time to go. The most important thing is finding possibilities during my short stay! The threat of a COVID-19 lockdown was also looming in the sidelines for most parts of the globe, so I also felt the need to leave for home as early as possible. But if there is one thing that I can genuinely say about my trip, it is that Japan is without a doubt an excellent place to do research work. Especially in Uji, where it is so serene, one can almost hear one's thoughts! Thoughts that lay out before your eyes to piece together, and questions that echo back as if to answer. It was a wholly "ichiban" research experience for me, with places to visit that inspire, delectable food to warm the soul,

research equipment to dazzle the mind, and new friends that could last a lifetime.

References:

1. J. J. BelBruno, *Chem. Rev.*, 2019, **119**, 94-119.
2. R. Obiles, U. I. Premadasa, P. Cudia, U. J. Erasquin, J. M. Berger, I. S. Martinez and K. L. A. Cimat, *Langmuir*, 2020, **36**, 180-193.
3. <http://inari.jp/en/>
4. https://en.wikipedia.org/wiki/Fushimi_Inari-taisha

If you are interested to participate in the KAPLAT Program of the Japan Society for the Promotion of Science (JSPS), please do the following:

1. Check this website: <https://www.kaplat-talentspot.jp/>
2. Email the JSPS KAPLAT program coordinators:

Hideaki Ohgaki, Ph.D.

Professor
Institute of Advanced Energy
Graduate School of Energy Science
Kyoto University
e-mail: ohgaki.hideaki.2w@kyoto-u.ac.jp

Imee Su Martinez, Ph.D. is the deputy director of the Office of International Linkages of the University of the Philippines System. She is also a professor at the Institute of Chemistry of the University of the Philippines in Diliman, Quezon City.