Young Career Focus: Professor Hyo Jae Yoon (Korea University, Republic of Korea)

Background and Purpose. SYNFORM regularly meets young up-and-coming researchers who are performing exceptionally well in the arena of organic chemistry and related fields of research, in order to introduce them to the readership. This Young Career Focus presents Professor Hyo Jae Yoon (Korea University, Republic of Korea).

Biographical Sketch

Professor H. J. Yoon

Hyo Jae Yoon obtained his BSc in chemistry from Sogang University (Korea). He then went on to pursue his PhD in materials chemistry at Northwestern University (USA) under the supervision of Professor Chad A. Mirkin. After a stint at Harvard University (USA) as a postdoctoral researcher in the group of Professor George M. Whitesides, he took up a position at Korea University in 2014.

INTERVIEW

SYNFORM *What is the focus of your current research activity?*

Professor H. J. Yoon My research group is concerned with resolving challenges in electronics and energy applications. Recently, we focused on three separate areas: molecular electronics and thermoelectrics and polymer mechanochemistry. In molecular thermoelectrics, we design and synthesize molecules and examine the Seebeck effect – conversion of heat into electricity – of them using our own metrology technique, which is based on a liquid metal electrode. In molecular electronics, we employ 2,2′-bipyridine-terminated *n*-alkanethiol, as a molecular diode, for drawing inferences on structure-tunneling relations. In polymer mechanochemistry, we are interested in discovering new mechanophores and mechanochemical reactions. We develop synthetic methodologies to incorporate new mechanophores into polymers, explore force-induced structural transformations of the mechanophores, and unveil detailed mechanisms of mechanochemical reactions.

SYNFORM *When did you get interested in synthesis?*

Professor H. J. Yoon My first experience in synthesis was during a master course where I was fascinated by asymmetric synthesis of biologically active molecules. This interest was further consolidated at Northwestern University where I was trained as an organometallic and coordination chemist, concerned with synthesizing supramolecular complexes as allosteric enzyme mimics. At Harvard, I utilized my synthesis skills and knowledge for the research of materials and surface chemistries.

SYNFORM *What do you think about the modern role and prospects of organic synthesis?*

Professor H. J. Yoon Organic synthesis in the last century has been predominantly explored under thermal or photochemical conditions. Reactions under conditions other than these traditional ones can offer new and/or greener synthetic routes. For example, part of our research concerns force-induced structural transformation of mechanophores. Mechanochemical conditions can allow one to steer chemical reactions toward routes that are inaccessible under the traditional conditions. Another example involves organic synthesis by means of electrochemistry – electrosynthesis and electric field-assisted catalysis. Electrosynthesis has a huge potential for efficient and sustainable synthetic methodologies and can be useful for industrial applications; electric field-assisted catalysis has been recently demonstrated in molecular tunneling devices. Indeed, these research areas have emerged in recent years and can pave the way for new applications.

SYNFORM *Could you tell us more about your group's areas of research and your aims?*

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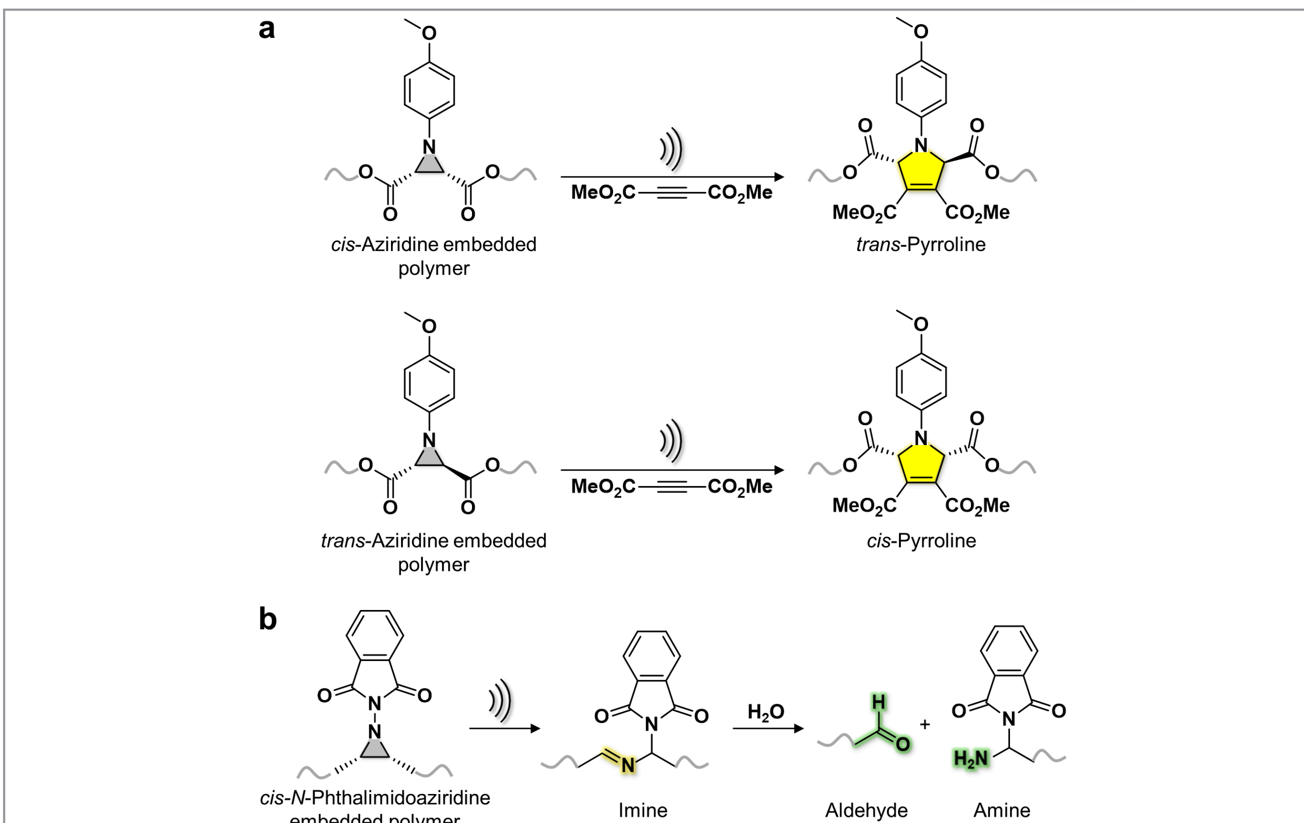
Professor H. J. Yoon Our research is fundamental in nature and based mainly on a physical-organic approach. Namely, one component in a system – it can be a chemical reaction or a solid-state device – is varied while keeping others constant. This approach permits one to draw structure–property relations and gives some hints as to solving problems of our interest; to quote Whitesides' words, it is like "a Swiss Army knife". Recently, our research group focused on investigating charge movement and energy conversion in well-aligned organic and organometallic molecules, and polymers on surface. Some of the currently ongoing projects aim to i) decipher mechanisms of charge transport, caused by external electric field or thermal gradient, at the organic-electrode interfaces, and ii) develop new mechanochemical reactions, which may be useful for tackling environmental problems caused by polymers.

SYNFORM *What is your most important scientific achievement to date and why?*

Professor H. J. Yoon In polymer mechanochemistry, we demonstrated the potential of aziridine for a new mechanophore. Last year, we successfully synthesized polymers containing trans- or cis-aziridines and found that the aziridines react with a dipolarophile under mechanochemical conditions based on ultrasound sonication although they are robust in structure – they do not undergo *cis–trans* isomerization under the same conditions (*Angew. Chem. Int. Ed.* **2020**, *59*, 4883) (Scheme 1a). This year, we synthesized a polymer containing aziridine with a different N-substituent, *cis-N*-phthalimidoaziridine. Interestingly, the aziridine undergoes migration of the *N*-phthalimido group to yield imine under mechanochemical conditions, but not thermal (*Angew. Chem. Int. Ed.* **2021**, *60*, 23564) (Scheme 1b). In the presence of water, the resulting imine is easily hydrolyzed, bifurcating into amine and aldehyde. In molecular thermoelectrics, we reported a new, efficient large-area technique to measure the Seebeck coefficient of molecular monolayers (*Nano Lett.* **2018**, *18*, 7715). Using this technique, we explored how the Seebeck coefficient is related to the (supra) molecular structure of the active component in molecular-scale tunneling devices (*Adv. Mater.* **2021**, *33*, 2103177; *ACS Cent. Sci.* **2019**, *5*, 1975).



Scheme 1 Mechanochemical reactions of aziridine mechanophores embedded in polymers