

Systematic Molecular Design of Ionic Liquids Toward Formation of Ideal SEI Layers on Lithium Metal Anodes

Haruchi Sakurai, **Presenter**,^a Nao Eguchi,^a Shun Ishii,^a Hiroki Nakagaki,^b Kazuhide Ueno,^b Masayoshi Watanabe,^b
Akihito Imanishi,^a Ken-ichi Fukui,^a and Shinji Kondou^{a,*}

^a The University of Osaka, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan

^b Yokohama National University, 79-5 Tokiwadai Hodogaya-ku, Yokohama 240-8501 Japan

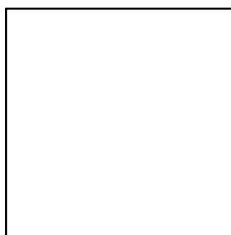
* Corresponding author's e-mail address: kondou.shinji.es@osaka-u.ac.jp

Solid electrolyte interphase (SEI), a passivation layer formed on the anode surface via reductive decomposition of electrolytes during initial charging, plays a critical role in stabilizing the cycle performance of batteries. Despite its importance, the intricate structure of the SEI and its correlation with physicochemical properties remain poorly understood. We have recently proposed a novel strategy for SEI structural engineering, termed “Domino-Decomposition Design”, which enables the selective formation of specific decomposition products at targeted reductive potentials through the chemical modification of imidazolium (Im)-based ionic liquids.¹ This selectivity is achieved by introducing electron-withdrawing substituents (e.g., fluoro, cyano, and allyl groups) and lengths of allyl chains linking them to the Im ring.

Systematic molecular design of ionic liquids offers a versatile platform for tailoring the structure and properties of complex SEI, thereby facilitating the rational design of “ideal” SEI for next-generation batteries. While previous studies have primarily focused on model gold electrodes, the present study targets the SEI layer formed directly on lithium (Li) metal anodes via chemical and electrochemical decomposition processes. By employing a series of chemically tailored cationic and anionic structures of ionic liquids, we aim to identify the key factors governing SEI formation using *in-situ* techniques such as atomic force microscopy (AFM) and X-ray photoelectron spectroscopy (XPS), developed in our laboratory.^{2,3}

References

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2. K. Fukui, *Bull. Chem. Soc. Jpn.*, **2018**, 91, 1210-1219.
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Haruchi Sakurai is a second-year master's student at the University of Osaka. His research focuses on SEI engineering through the molecular design of ionic liquids, combined with *in-situ* interfacial analyses. He has received several honors, including the Poster Award at the 14th Ionic Liquid Symposium (Japan), the Presentation Award at the 92nd Annual Meeting of the Electrochemical Society of Japan, and a research grant from Kato Foundation. He has also been awarded a Ph.D. fellowship from the University of Osaka.