表面イオニクス・触媒化学 Surface Ionics・Catalysis

関根　泰　Yasushi SEKINE

TEL：03-5286-3114
e-mail：ysekine@waseda.jp
URL：https://ysekine.w.waseda.jp/

1993年東京大学工学部応用化学科卒、1998年同博士（工学）、1998～2001同助手、2001より早大助手・講師・准教授を経て2012年～教授、2011年～JSTフェロー、2017年～Fuel誌プリンシパルエディター、2018年～JST「さきがけ」研究総括、文部科学省環境エネルギー委員、NEDO未踏チャレンジプログラムオフィサー、日本政府グリーンイノベーション戦略推進会議委員、日本学術会議連携会員、2020年～イギリス王立化学会フェロー（FRSC）、2019年日本化学会学術賞、2020年文部科学大臣表彰科学技術賞

B. Eng. (1993 Univ. Tokyo), Ph.D. (1998 Univ. Tokyo), Res. Assoc. at Univ. Tokyo (1998-2001), Res. Assoc. at Waseda Univ. (2001-2003), Professor, Faculty of Advanced Science and Engineering, Waseda University (2012-), Principal Editor of FUEL; Elsevier (2017-), Research Supervisor of JST-PRESTO (2018-), The Chemical Society of Japan; Award for Creative Work(2019), The Commendation for Science and Technology by the MEXT(2020), Fellow of Royal Society of Chemistry (FRSC) (2020-)

固体酸化物表面の酸素・水素イオンの拡散現象は表面イオニクスと呼ばれ、電気化学やセンサー・触媒などにおいて新しい機能をもたらす。固体酸化物バルク内のイオン伝導についてはすでに多くの評価手法があるものの、比較的低温での表面イオニクス（とりわけプロトニクス）の評価手法については研究開発が期待されている。これまで我々は、電気化学的手法である交流インピーダンス法を用いた酸化物表面への水の吸着に伴う表面プロトニクスの発現についての解析手法を編み出してきた。これにより、我々は世界で初めてアンチアレニウス型（100～200度において低温にするほど表面プロトニクスが加速する）の現象を発見し、これを表面プロトニクスを生かした応用へと展開してきた。さらに酸化物表面の構造と物性が吸着やイオン伝導に与える影響についてもX線分光をはじめた多様な手法を用いた評価を行い、次世代の低温作動表面イオニクス材料の開発を進めている。

Migration phenomena of oxygen and hydrogen ions on the surface of solid oxides are called surface ionics, and they provide new functions in electrochemistry, sensors, and catalysts. While there are already many evaluation methods for ionic conduction in bulk solid oxides, research and development of evaluation methods for surface ionics (especially protonics) at relatively low temperatures is expected. We have developed an analytical method for surface protonics associated with water or hydrogen adsorption on oxide surfaces using the AC impedance method, which is an electrochemical technique. This has led us to the world's first discovery of an Anti-Arrhenius-type phenomenon (surface protonics accelerates at lower temperatures of 373 K-473 K), which we have applied to applications that take advantage of surface protonics. We have also studied the effects of oxide surface structure and physical properties on adsorption and ionic conduction using various techniques including X-ray spectroscopy, and are developing next-generation low-temperature working surface ionics materials.

■代表論文および著書 /Representative publications

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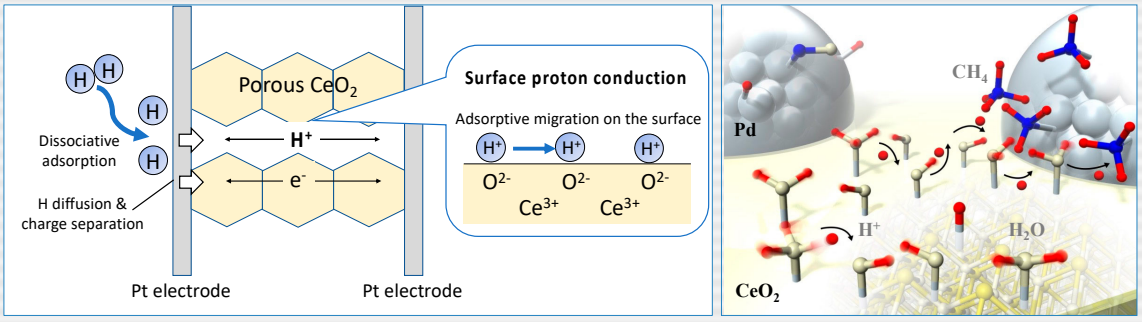

左：表面プロトニクスを交流インピーダンス法により評価、
右：表面プロトニクスは低温で多様な用途に展開可能
Left: Surface protonics evaluated by AC impedance method;
Right: Surface protonics can be deployed in various applications at low temperatures