Abstract

[Project Information]

Project Title :	Development of Next-generation Marine-coating Film and Process Realizing Energy Saving and Low Environmental Load
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Principal Investigator :	Tsujii Yoshinobu
(PI ORCID) :	ORCID0000-0002-4357-6902
Principal Institution :	Institute for Chemical Research, Kyoto University Gokasho Uji-city, Kyoto, JAPAN 611-0011 Tel: +81774383162 E-mail: tsujii@scl.kyoto-u.ac.jp
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[Abstract]

This study highlights the potential of our soft and resilient tribology (SRT) technology as a disruptive innovation and establishes the technological foundation for *next-generation marine-coating films and processes, realizing energy-saving and low environmental loads*. A novel strategy leveraging the SRT technology was implemented to provide advanced stealth functionalities, including the suppression of marine organism adhesion, reduced hydrodynamic drag, and self-healing properties. Furthermore, this study aimed to innovate the coating process itself by reducing the emission of volatile organic compounds (VOCs) through the application of SRT skin technology.

To achieve this common goal, three research groups collaborated by sharing their independently developed SRT materials and dividing the project into the following coordinated tasks:

1. **Sub-theme 1**: Production platform establishment
2. **Sub-theme 2**: Field evaluation for drag reduction and film stability
3. **Sub-theme 3**: Real-world assessment of antifouling performance.

The different challenges—ranging from material manufacturing to functional performance—were investigated both independently and simultaneously. In addition to developing accelerated testing methodologies, we established a rapid research and development cycle that integrated material design and synthesis, basic property evaluation, real-world performance testing (hydrodynamic drag reduction and antifouling), and iterative feedback to material design. This was facilitated by a collaborative research network of industry partners, academic institutions, technical colleges, and international collaborators.

The key research achievements are as follows.

- **Sub-theme 1**: From both fundamental and applied perspectives, we (i) developed an SRT skin-generation platform based on rational material design, (ii) validated its applicability in practical coating processes, and (iii) clarified the structure–property–function relationships, thereby establishing the material design guidelines.
- **Sub-theme 2**: We successfully (i) developed self-healing SRT skins, (ii) demonstrated the effectiveness of SRT coatings in reducing the fluid resistance, and (iii) confirmed the durability and antifouling capabilities of the coatings through field trials.
- **Sub-theme 3**: Marine biofouling was quantitatively assessed in laboratory, semi-natural, and natural marine environments to (i) verify biocompatibility, (ii) confirm coating stability in seawater, (iii) evaluate adhesion suppression performance under controlled conditions, and (iv) demonstrate real-world antifouling efficacy.

In general, this study identifies the key challenges and proposes integrated solutions. The research and development of next-generation antifouling coatings can be further advanced by collaborating with the manufactures of ship-bottom paints to facilitate implementation in real-time scenarios.

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