Collaboration Platform for Research and Development of Solid Oxide Fuel Cells

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INTRODUCTION

Toward the development of a Solid Oxide Fuel Cell (SOFC) system that is economically feasible in existing markets for energy systems, scenario based studies of the introduction of SOFC systems are required that draw the findings from specific research studies together holistically. Such scenario assessments require concurrent evaluations of cost, environmental impact, and performance related attributes in terms of various aspects of an SOFC system such as cell characteristics, module configurations, system characteristics, manufacturing processes and their facilities. Furthermore, changes in energy infrastructures, effects of replacement of existing energy technologies, and changes in inter-industry commodity flows induced by the newly established fuel cell manufacturing must be assessed. The concurrent and interdisciplinary nature of these studies requires collaborations among researchers and developers from a wide range of disciplines. The goal of the research is to construct an interdisciplinary collaboration platform (hereafter "collaboration platform") for holistic design and evaluation at the research and development phase of SOFC systems and other innovative technologies for achieving an environmentally and economically sustainable future society.

COLLABORATION PLATFORM

A schematic image of the platform is shown in Fig. 1. The platform consists of six information service domains that are interconnected by a data exchange infrastructure. These are the "GUI (graphic user interface)", "regional information", "LCA (life cycle assessment)", "design specification", "failure forecasting", and "simulation" domains. The "regional information" domain handles regional information parameter sets that represent the social system – such as geographical information, environmental restrictions, energy demands. The "GUI " domain provides a standardized, user-friendly environment for flexible support of user interaction with the collaboration platform. The "LCA" domain uses a scenario-based LCA method (1) to evaluate the life cycle impacts of large-scale introduction of the SOFC system into the energy market, including environmental impacts of SOFC manufacturing processes and commodity flow changes. Because the scenario-based LCA framework itself does not provide any assumptions and predictions, the framework will be combined with the models in the "simulation" domain to assess the introduction effect of the SOFC system into the market. Predictive forecasting of failures that could occur as a result of a given set of system specifications as well as recommendations for specification changes to prevent the occurrence of the identified failures are performed in the "failure forecasting" domain. The prevention of failures by predictive analysis at the design phase is fundamentally important especially for SOFC technologies. This is because the lifetime of SOFC systems is long and the investment cost is large, which makes the benchmark testing expensive in terms of both economic cost and time. We use the Stress-Strength Model system (2) developed for the predictive analysis of mechanical designs as a basic architecture for failure prevention of SOFC systems by predictive analysis. To facilitate the mechanism of failure forecasting from a given set of design specifications, we have developed a structured markup language for describing design specifications of chemical devices (3) based on the meta-language, XML (eXtensible Markup Language). A prototype of an agent-based mechanism to elucidate potential failures for a given specification was developed and will be implemented in the "Simulation" domain. The dynamic interactions among these three domains will make possible an innovative design approach that could help designers to prevent potential failures for a given SOFC design specification, thereby supporting the process of designing new specifications for more robust systems (Fig. 2). The "simulation" domain of the platform handles all of the simulation-based evaluations of the SOFC characteristics. Details of each domain are presented in the paper.

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REFERENCES

1. Y. Fukushima, M. Hirao, *Int. J. LCA*, In press.
2. Y. Tamura, Y. Iizuka, *J. Japanese Society for Quality Control*, **32**, 122 (2001).
3. M. Koyama, Doctoral thesis, The University of Tokyo, (2002).

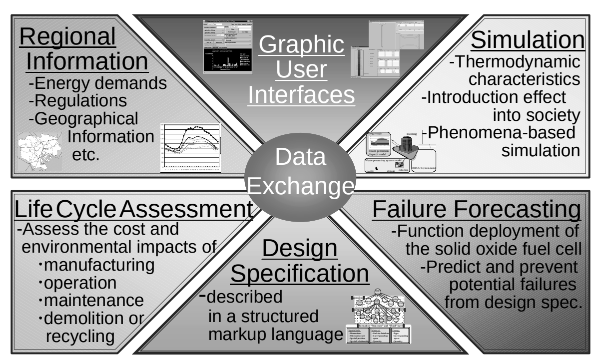

Fig. 1 Schematic of the collaboration platform

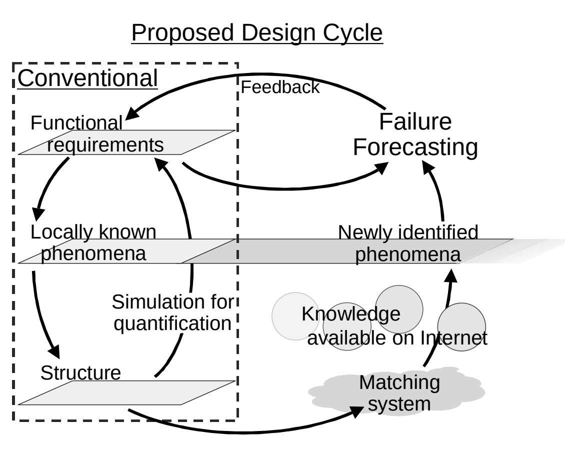

Fig. 2 Design process for failure prevention by predictive analysis