FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Innovation in Oxygen-Enhanced Combustion by Fast Oxygen Permeable Membranes	
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1. Background of research

The efficient usage of energy is quite important issue to reduce the amount of carbon dioxide emission. By using pure or enriched oxygen in combustion systems such as gas turbines and melting furnaces, system efficiencies can be improved. In addition, pure oxygen combustion systems are suitable for carbon dioxide capture and storage (CCS), since emission gas composes of only water vapor and carbon dioxide. An another advantage of oxygen-enriched combustion is to reduce the emission of dioxin. In this study, novel oxygen permeable membranes will be developed, which reduce power consumption for pure oxygen production. To realize such the system, enhancement in oxygen permeation flux and reduce in operation temperature are necessary.

2. Research objectives

One of the important issues is to reduce operating temperature of oxygen permeable membranes, which is currently 800 to 1000˚ C. Another issue is to double the current oxygen permeation flux, which is approximately 100 L/min/m^2. To meet the targets, novel ceramics-based membranes will be explored. In addition, thin film processing techniques will be developed.

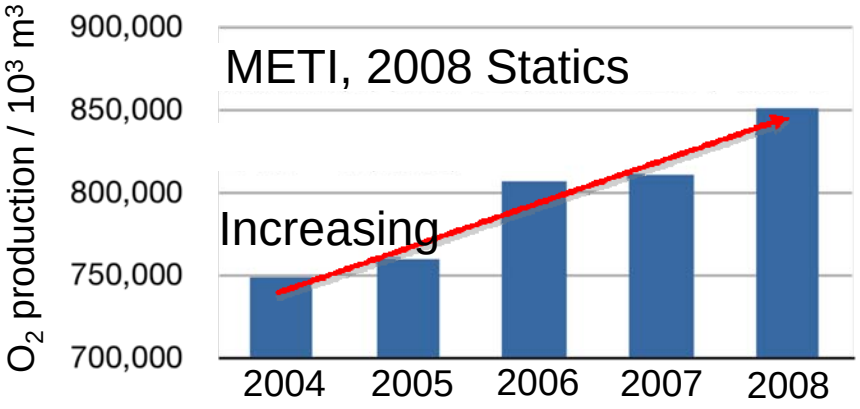
3. Research characteristics (incl. originality and creativity)

By using the novel oxygen permeation membranes, expected oxygen production systems will be more cost-effective and miniaturized. From scientific view points, dissociation process of oxygen molecules and transport phenomena in oxygen permeation membranes will be clarified. In addition, state-of-the-art thin-film production techniques will be applied to prepare high-quality oxygen permeable thin films supported on porous substrates.

4. Anticipated effects and future applications of research

The expected oxygen production systems can be utilized in mid-size combustion system and melting furnaces. In addition, the use of pure or enriched oxygen is highly demanded in food and medical business, including potential applications. For example, small and cost-effective oxygen production systems are highly demanded for medical use. The novel oxygen production system may be suitable for such the application.

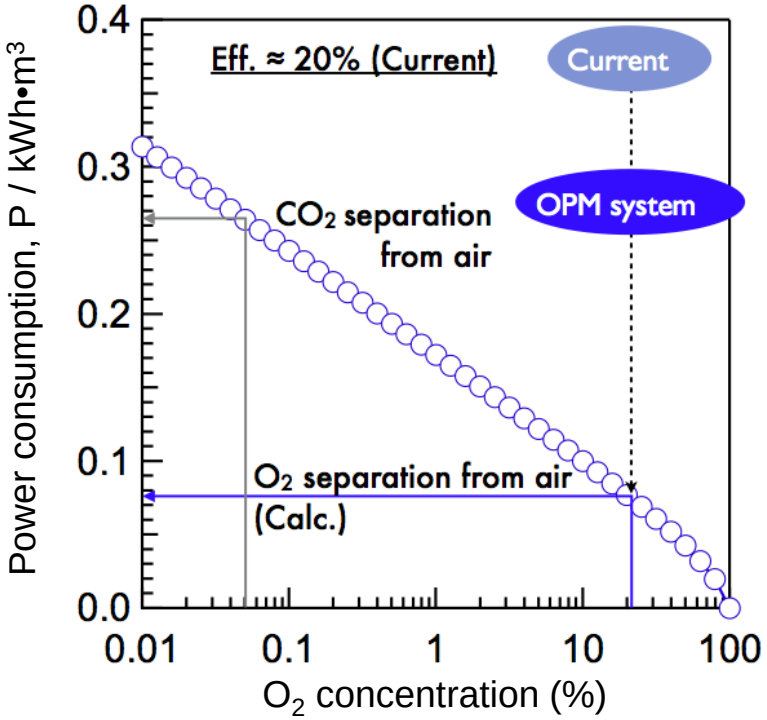
Background

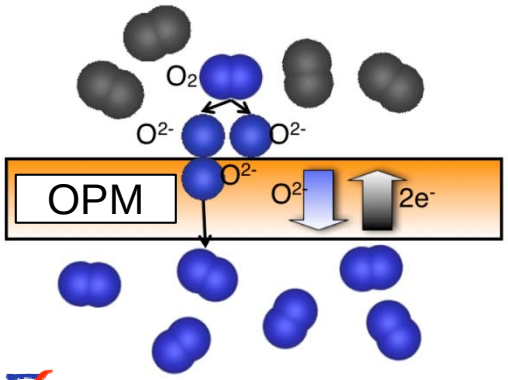


Possible Applications

- Melting furnace
- Smelting
- Syngas production
- Medical
- Combustion system

- Enhancement in efficiency, Clean tech, Suitable for CCS





- Pure oxygen separation
- Continuous separation
- Low initial investment cost
- Compact and High efficiency

High P(O_2)

Mixed conductor
(Dense ceramics)

Low P(O_2)

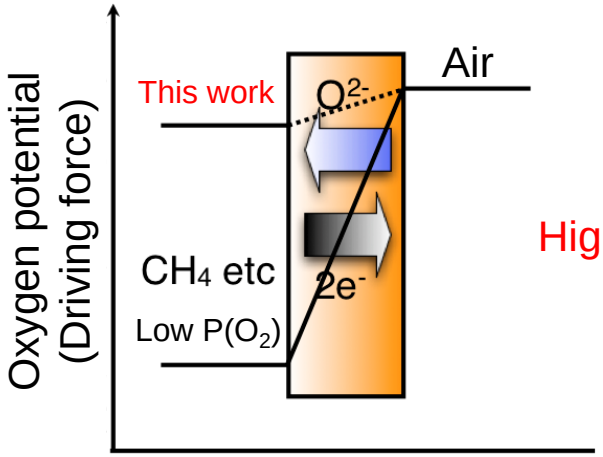
Tasks:

Increase in O_2 flux

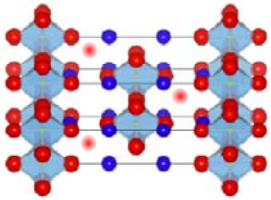
Reduce in $T_{op.}$

Tasks and Prospects

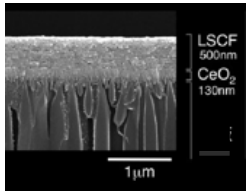
Operation under Low $P(O_2)$ gradients



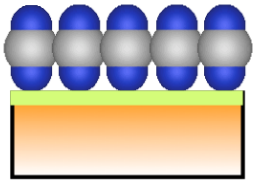
Novel membranes



High-quality thin films

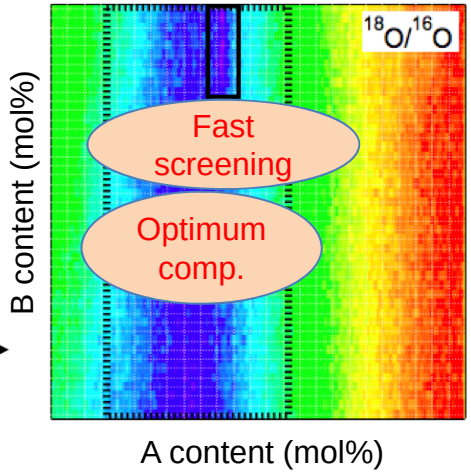


Enhancement in surface exchange reaction



Catalysts
for dissociation

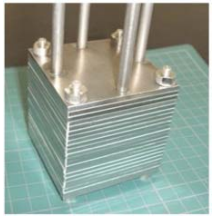
Fast screening
by using SIMS



A compact and high-efficiency O_2 production system will be developed

Industries

Melting furnaces
Combustion of asbestos
Dioxin-free combustion



<u>Not only large-scale, but also mid-scale application is possible.</u>

Medical application

- Cost-effective O_2 supplier
- Home-use O2 supplier

Emerging field in Solid State Ionics

- Cathode materials in SOFCs
- Application to metal-air batteries
- Membrane separation and energy conversion