Short Introduction

- Dr. Takagi is a SOFC product development manager at Saint-Gobain, responsible for managing its major projects as well as driving the direction of its R&D portfolio.
- As a part of his responsibilities, he works closely with diverse global companies involved in the energy and engineering field.
- Before joining Saint-Gobain in 2014, he worked for SONY and Ebara Ballard, where he was responsible for variety of fuel cell system integration and critical component developments.

E-mail: yuto.takagi@saint-gobain.com
SAINT-GOBAIN, ONE OF THE WORLD’S TOP LEADING INDUSTRIAL CORPORATIONS WITH 350 YEARS OF HISTORY

Operations in 66 countries

Over 170,000 employees

Amounts in €bn

<table>
<thead>
<tr>
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<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>39.1</td>
</tr>
<tr>
<td>Operating income</td>
<td>2.8</td>
</tr>
<tr>
<td>Recurring net income</td>
<td>1.4</td>
</tr>
</tbody>
</table>

R&D in Saint-Gobain

8 cross-business R&D centers

3,700 people

One of the top 100 global innovators*

* Source: Thomson Reuters

Saint-Gobain celebrates its 350th anniversary

Creation of the Manufacture royale des glaces

Invention of glass table casting

Saint-Gobain expands in Europe: Germany, Italy, Belgium and Spain

Saint-Gobain diversifies into new markets and new products

Refocus on materials with a high technology content and entry into building distribution and plasterboard

Merger between Pont-a-Mousson and Saint-Gobain. Ongoing internationalization

Saint-Gobain focuses its strategy on habitat

2016

2016

1665

1688

1850

1900

1900

1950

1970

1990

2007

2015

CERAMIC MATERIALS
SOFC DEVELOPMENT HISTORY AT SAINT-GOBAIN
Internally funded for 10 years with external collaborations

- **2005**: Internal project started, material and process development
- **2006**: Co-sintered button cell with OCV > 1.0V
- **2009**: ‘Button Stack’ developed with all relevant features
- **2010-2011**: Scale-up, performance and degradation improvements
- **2012**: 150W stack developed, internal testing begins
- **2013**: Degradation rate of 0.2%/khr demonstrated; Public unveiling
- **2014**: 150W module for testing developed
- **2015**: Industrial style 150W module development

**Recent addition**: Fraunhofer IKTS (Germany)

Collaboration Partners

- United States
  - 1. MIT Performance Modeling & Materials
  - 2. Boston University Materials Development
  - 3. Northwestern University Microstructure Analysis
  - 4. U. of Washington Sintering Theory
  - 5. Case Western University Degradation Mechanism
  - 6. PNNL Sealing Technology (license)

- Spain
  - 7. U. of Saragossa Powders

- Italy
  - 8. U. of Pisa Modeling

Stack Development & Testing

Northboro, MA
INNOVATIVE SG ALL-CERAMIC SOFC STACK

Key Differentiators

1. High Durability & Reliability
   Thin ceramic interconnects
   Well bonded interfaces

2. Low Cost Manufacturing & System
   Multi-cell co-firing
   Multi-layer processing

3. Compact Design
   Good volumetric power density

Modular Ceramic Stack

Face Seal ‘Glaze’

Gas Transport Channels
VALUE CHAIN FOR MARKET APPROACH AND SG’S POSITION
From Powder, Stack to Hot box

Stack/Module
Saint-Gobain

System Partner

Utility/Distribution

600W Module

2.5 kW Module

Pouder → Cell → Stack → Module → Hot Box → System Integration → Appliance → Utility/Distribution

SG domain

CERAMIC MATERIALS

SAINT-GOBAIN