Development of Ceramic Materials and Structures for Emerging Applications in Hydrogen Economy

Balagopal N. Nair
R&D Center, Noritake Company LTD., Miyoshi, Aichi, Japan. &
NRI, Department of Applied Chemistry, Curtin University of Technology, Perth, Australia.
E-mail: b.nair@curtin.edu.au

Key Words: Porosity, Separation, Nanostructures, Absorbents, Catalysts, Membranes, Electrolytes

Hydrogen is one of the most important energy carriers and it is widely believed that its production, purification and application will offer new opportunities in the ceramic business. Electrolytes for fuel cells such as SOFC, DMFC and PEFC, absorbents for the storage or selective separation of hydrogen/CO_2, gas separation membranes, catalysts, sealing materials and substrates are some of the candidate products.

Figure 1: An all ceramic hydrogen separation module. The module is capable of directly delivering enough hydrogen to run a 1kW class fuel cell from a membrane based reformer.

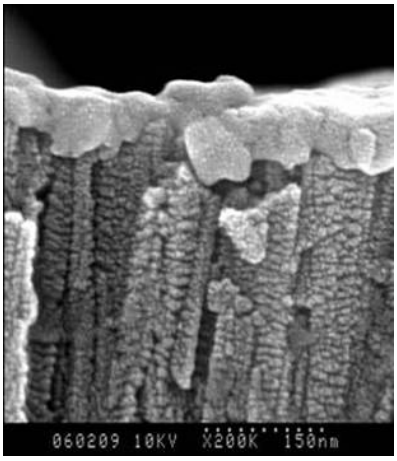

Figure 2: A metallic thin film supported on an oriented porous layer of zirconia. Structures like this could find applications as fuel cell electrolytes. Ref: Nair et al., Advanced Materials, 17 (2005) 1136-1140.

Several research works in this regard are currently ongoing in the Noritake Company Ltd. Microporous hydrogen selective membranes (Figure 1), zeolite based catalytically active hydrogen purification membranes, as well as proton and oxygen conducting inorganic and inorganic/organic hybrid electrolytes for fuel cell applications are some of the examples. We have developed nanostructured materials and membranes from a variety of ceramics such as Al_2O_3, ZrO_2 (Figure 2), SiC, Si_3N_4 and SiO_2 in recent years. In the presentation, I plan to introduce some of these topics with special emphasis on the R&D frontiers requiring attention of talented researchers.

Acknowledgements

This presentation is an overview of the research works I was involved during the past 6-7 years. Several people at Noritake, University of Tokyo and Curtin University of Technology have contributed directly to this work. Some of these works have also received significant research funding from organizations such as NEDO (New Energy and Industrial Technology Organization) and JST (Japan Science and Technology Agency). My sincere acknowledgements to all these people and organizations for the supports received.

About the Speaker

Name: Balagopal N. Nair

Nationality: India

Affiliation: R&D Center, Noritake Company LTD., Miyoshi, Aichi, Japan.
Web: //www.noritake.co.jp
&
Nanochemistry Research Institute (NRI), Department of Applied Chemistry, Curtin University of Technology, Perth, WA, Australia
Tel: 61-8-9266-1386 FAX: 61-8-9266-4699
E-mail: b.nair@curtin.edu.au
Web: www.nanochemistry.curtin.edu.au/index.cfm

Title: Adjunct Professor, Curtin University of Technology

Dr. Balagopal Nair (Balu) received his Bachelor of Engineering degree in 1989 from the University of Kerala, India and his Doctor of Engineering degree in 1998 from the University of Tokyo, Japan. He started working with Noritake in April, 2001 and in July, 2005 got deputed to Curtin University of Technology to run a collaborative project on nanotechnology.

His research is focused on the development of nanoparticles, nanopores and structures made of them such as thin films, membranes, electrolytes and catalysts. He has authored more than 40 research papers, 60 conference presentations and 25 IP's.

Balu lived and studied/worked in Japan for more than 10 years - more than 50% of his adult life- of which more than 4 years were spent in Tokai area. He has a deep affection and respect towards Japanese culture and Japanese people, particularly the elderly who have devoted their lives to rebuilding Japan to a technology powerhouse.

Balu, like most men of his age, is struggling to redefine his habits and hobbies to suit his age, time, family life and official responsibilities. At this moment he still plans to practice angling (fishing) as a new hobby with his young daughter so she can learn to appreciate and respect the fullness of nature.