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A Report on

**Workshop on Development of Lithium based
Ceramics for Tritium Breeding (LCTB-2011)**

Held on

**June 10- 11, 2011, in Department of Ceramic Engineering,
National Institute of Technology, Rourkela**

under the auspices of

**Board of Research in Fusion Science and Technology (BRFST)
& Department of Ceramic Engineering NIT Rourkela**



A brief report on the Workshop on Development of Lithium based Ceramics for Tritium Breeding (LCTB-2011)

This report is the brief description of “**Workshop on Development of Lithium based Ceramics for Tritium Breeding (LCTB-2011)**” which was held on June 10- 11, 2011, Department of Ceramic Engineering, National Institute of Technology, Rourkela. Workshop was held under the auspices of **the** Board of Research in Fusion Science and Technology (**BRFST**) & Department of Ceramic Engineering NIT Rourkela.

One of the motivations to organize this workshop is to bring together the leading materials scientists, and engineers from around the country to share their experience on lithium based ceramic breeder materials for use in Test Blanket Module (TBM) for tritium extraction. This workshop has provided a forum of specialists involved in the design, research, and development and testing of materials and components for lithium ceramic based breeding blankets.

Among other directions, the conference focused on some topical areas, including Progress in Ceramic Breeder Material Development, Breeder Material Properties, Performance study of Pebbles, Pebble bed Experiments and Modeling. The advances in the areas of different processing routes and aspects of Lithium based ceramic materials developments, thermal, mechanical & micro-structural evaluation for property optimization, modeling of thermal and mechanical properties and trends of future developments were largely discussed in the Workshop. Besides various technical sessions, a **Panel discussion on “Development of lithium based ceramic breeder materials for TBM: Future Perspectives”**, focussed sessions to explore future possibilities of different type of collaborations required to carry out an effective and fruitful research in the area of breeder materials. Besides the Invited Lecture sessions, a separate contributory session was also organized for students working in this area.

More than 25 delegates participated in **LCTB-2011**. The participants for this conference were from BARC, Mumbai, IPR, Gandhinagar, BIT, Patna, KIIT, Bhubaneswar, U.G.I.E, Rourkela and NIT, Rourkela. The Chief Guest for the Inaugural function was Dr H S Maiti,

CGCRI, Kolkata. Two member from BRFST Dr. A. Ravi Kumar, Dr. J. Govindarajan were present and given their valuable suggestions to the project PI and students. Nearly 20 student delegates from NIT as well as from different academic institutions all over the country also actively participated in the workshop. Members are advised to project students and research scholars to visit IPR and get more acquainted with fusion related activities.

In the panel discussion session the following topics were discussed in detail and the and suggestions and comments are summarized here.

- Panel members agreed that there are many reports on Li_2TiO_3 synthesis and sintering. But a detailed study is required to understand the effect microstructure on different properties of Li-Ceramics.
- Further studies are required on Li_4SiO_4 , to control phase stability, weight loss and get reasonable density.
- Experts advised to study the atomistic mechanism to understand Li-scavenging and Li-diffusion through bulk ceramic. Whether it is vacancy controlled or it depends on defect structure?
- It was advised to study the densification of non-stoichiometric lithium titanate (where Li/Ti ratio >2).
- Panel members proposed to study composite of Lithium ceramics (Li_2TiO_3 , Li_4SiO_4 and Li_2ZrO_3) to get better Lithium density, tritium release and improvement in other physical properties.
- Prof. H. S. Maiti suggested to study in details the effect of doping (Ca, Mg and dopant must not be harmful to tritium generation) on Li diffusion, vacancy concentration and finally on tritium release.
- To study rate of degradation of Li ceramics with irradiation.

- Panel members agreed that further studies are required to understand that tritium diffusion in ceramic is grain boundary or vacancy controlled. (mass transport study is important)

By this workshop, advance of key technologies for solid breeder blanket development was shared among the participants. Also, desired direction of further investigation and development was recognized. The abstract of the 15 presentation were given and discussed in the workshop are published in the proceeding. The announcement of the workshop, its brochure, the glimpse of the proceeding cover page, BRFSST chairman's message, the program schedule and the list participants are given in Appendix.

Workshop Organising Committee:

Chairman: Prof .H.S. Maiti, NIT Rourkela

Co-Chairman: Prof. J.Bera, NIT Rourkela

Convener: Prof. R.Mazumder, NIT Rourkela

Mr..P.Chaudhuri, IPR Gandhinagar

Co-Convener: Prof. S.Bhattacharyya,NIT Rourkela

Dr. A. Ravi Kumar, IPR Gandhinagar

Local Organising Committee:

Prof. S.K Prathihar, NIT Rourkela,

Prof. B.B. Nayak, NIT Rourkela,

Prof. R.Sarkar, NIT Rourkela,

Prof.S. Pal, NIT Rourkela,

Prof. D.Sarkar, NIT Rourkela,

Prof. A. Chowdhury, NIT Rourkela,

APPENDIX

First Announcement of Development of Lithium based Ceramics for Tritium Breeding (LCTB-2011)

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P.C. Panda,
Director NIT, Rourkela

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ABOUT DEPARTMENT OF CERAMIC ENGINEERING

Established in 1994, the department has already been recognized nationally for its quality teaching, research both in undergraduate and postgraduate programs. A team of highly qualified and young, dynamic faculty members are engaged in the research activities of both conventional and advanced ceramics. The department has state of the art laboratories on advanced ceramic processing and characterization. The faculty members have obtained a number of research projects from DST, DRDO, BRFST, CSIR, BARC etc. It has also developed close industrial linkages (in terms of short term project, collaborative research and testing) with different neighbouring industries like Tata steel, TRL, OCL, IFGL etc. The graduates of this department are widely accepted in both core & IT industries, academic and research institutes as well as in different business schools in India and abroad.



"BRFST TOPICAL MEETING SERIES-

**WORKSHOP ON
DEVELOPMENT OF LITHIUM
BASED CERAMICS FOR TRITIUM
BREEDING"**

(10th -11th June, 2011)

**R MAZUMDER
&
P.CHAUDHURI
Convener**

**S.BHATTACHARYYA
&
P. M RAOLE
Co-Convener**



**ORGANIZED BY
DEPARTMENT OF CERAMIC ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
ROURKELA-769 008, ORISSA
<http://www.nitrkl.ac.in>**

**In collaboration with
INSTITUTE OF PLASMA RESEARCH (IPR),
GANDHINAGAR**



**Sponsored by
BOARD OF RESEARCH ON FUSION
SCIENCE AND TECHNOLOGY (BRFST)**



Development of Lithium based ceramics for Tritium Breeding

June 10th & 11th, 2011

Department of Ceramic Engineering
NATIONAL INSTITUTE OF TECHNOLOGY
ROURKELA 769008, ORISSA, INDIA

Date: 27.04.2011

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Dear Sir,

I am happy to inform you that the Department of Ceramic Engineering, National Institute of Technology (NIT), Rourkela is organizing **BRFST TOPICAL MEETING SERIES- "WORKSHOP ON DEVELOPMENT OF LITHIUM BASED CERAMICS FOR TRITIUM BREEDING"** during 10th to 11th June 2011. This workshop will be attended by eminent personalities from academia and research laboratories in the area of ceramic materials and materials science in general and Lithium ceramic breeder material in specific, as well young research scholars from different academic and research institutes.

I have enclosed the workshop brochure for your kind reference, wide circulation and active participation.

With sincere regards

(R. MAZUMDER)

Convener,

and

P. CHAUDHURI

Convener

COVER PAGE OF THE ABSTRACT BOOK OF LCTB - 2011

LCTB-2011

BRFST TOPICAL MEETING SERIES
**WORKSHOP ON DEVELOPMENT
OF LITHIUM BASED CERAMICS
FOR TRITIUM BREEDING**
10th -11th June, 2011

Abstracts

ORGANIZED BY
DEPARTMENT OF CERAMIC ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA

In collaboration with
INSTITUTE FOR PLASMA RESEARCH (IPR), GANDHINAGAR

Sponsored by
BOARD OF RESEARCH ON FUSION SCIENCE AND TECHNOLOGY

50 Golden Jubilee 1951-2020
nit rourkela
Engineering the future

BRFST India

MESSAGE

Prof. P. I. John

Chairman

Board of Research in Fusion Science and Technology



The first generation fusion devices will be fuelled by Deuterium and Tritium, the heavier isotopes of Hydrogen. Deuterium is readily available in nature. Tritium, being short lived, has to be bred from Lithium. This is done in situ in fusion reactors using the energetic neutrons from fusion reactions.

Fusion blanket technology addresses the issues of preparing and exposing lithium-bearing chemicals to the neutron flux, extracting heat and Tritium after nuclear reactions and the materials issue relevant to such environments. This is a critical fusion reactor technology and India is in the process of its indigenous development. In addition to activities in national laboratories, a number of educational institutions have been funded by the Board of Research in Fusion Science and Technology (BRFST) to work on different aspects of this problem.

I am happy to note that an interaction workshop is being organized at NIT, Rourkela to bring together practitioners of this advanced technology to compare results from their work and to promote a better understanding.

I would like to convey my best wishes to this workshop and hope that the participants would have an intellectually stimulating event, which will promote close collaboration between all participating organizations.

Prof. P. I. John

Chairman

Board of Research in Fusion Science and Technology

PROGRAM SCHEDULE OF LCTB - 2011

10th June 2011, (Friday)

Venue : Mechanical Engineering Department Seminar Hall

| Time | Programme |
|----------------------|---|
| 9:00 -9:30 | Registration |
| 9:30 – 10:45 | Inaugural Session |
| 10:45 – 11:15 | High Tea |
| | <u>Invited Theme Lectures I</u> |
| 11:15 – 12:00 | Dr J.Govindarajan, BRFST |
| 12:00 – 13:00 | Dr. P.M.Raole ,IPR Gandhinagar Fusion Reactor Materials – An Overview |
| 13:00 – 14:30 | Lunch |
| | <u>Contributory Lecture Session I</u> |
| 14:30 – 15:00 | P. Chaudhuri, Lithium based Ceramic as Tritium Breeder Materials for Test Blanket Module in ITER |
| 15:00 – 15:30 | T.V.Vittal Rao, Fuel Chemistry Division, BARC , Mumbai Preparation of Li_2TiO_3 Pebbles by Sol-Gel Process for ITER Programme |
| 15:30 – 16:00 | Amit Sinha, Energy Conversion Materials Section, BARC,Mumbai Combustion Synthesis of Lithium Titanate (Li_2TiO_3) based Ceramics |
| 16:00 – 16:30 | Aroh Shrivastava, IPR, Gandhinagar Estimation of Effective Thermal Conductivity of Lithium Ceramic Pebble Bed in Fusion Blanket |
| 16:30 – 16:45 | Tea |
| 16:45 – 17:15 | R.Mazumder, NIT, Rourkela Development of Lithium Titanate Ceramics by Autocombustion Technique: Synthesis, Sintering and Characterization |
| 17:15 – 18:30 | Focused Discussion on Future of Breeder Materials Research |
| 20:30 | Dinner |

11th June 2011, (Saturday)

Invited Lecture Session II

9:30 – 11:00 Lab Tour on Breeder Materials & Pebble Processing

11:00 - 11:30 Tea

11:30 - 12:15 P.Chaudhuri, IPR Gandhinagar
Overview of Design and Thermal-hydraulic Analysis of Indian
Solid Breeder Concept

12:15 – 13:00 S.K.Sinha, BITS, Patna
Lower Activation of Tritium Breeding Material – Challenges and
Probable Steps

13:00 – 14:30 Lunch

Contributory Lecture Session II

14:30 – 14:50 Dhiraj Kumar Rana, Birla Institute of Technology, Patna
Thermal and Neutron irradiation behaviour of sol gel prepared
 Li_2TiO_3 ceramics

14:50 – 15:10 S.K.S Parashar, KIIT University, Bhubaneswar
Challenges in Li-Based Materials Synthesis for Tritium Breeding

15:10 – 15:30 A. Choudhary, NIT, Rourkela
Synthesis of Lithium Orthosilicate by Sol-Gel Technique: Effect
of Two Source of Silica

15:35 – 16:30 **Discussion and Valedictory Session**

High Tea

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DEPARTMENT OF CERAMIC ENGINEERING

BRFST TROPICAL MEETING SERIES-WORKSHOP ON DEVELOPMENT OF LITHIUM BASED CERAMIC FOR TRITIUM BREEDING

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Photographs of LCTB - 2011



