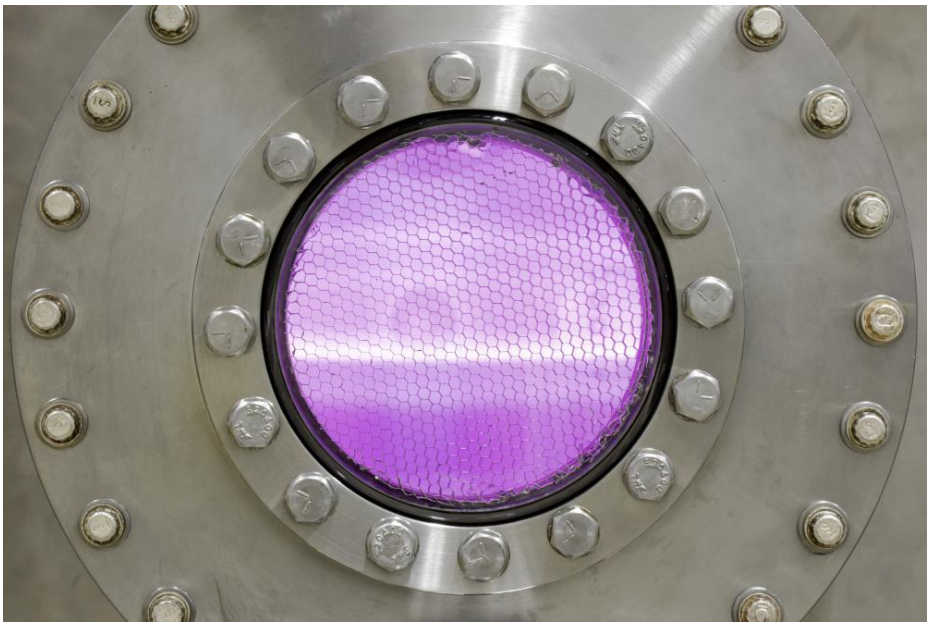
DEVELOPMENTS IN MATERIALS RESEARCH FOR FUSION



a strategic discussion led by the

Fusion Power Co-ordinating Committee (FPCC)

14 February 2019

9h-13h00

Centre de Conférences Ministériel
27, rue de la Convention
75015 Paris

International Energy Agency (IEA)

The IEA is an autonomous agency established in November 1974. Its mandate is two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply and to advise member countries on sound energy policy. The IEA carries out a comprehensive programme of energy co-operation among 29 advanced economies[1]. The Agency aims to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations, and other stakeholders.

Since the 1980s, the IEA has continued to build good working relationships with countries beyond its membership, in particular major energy consuming, producing and transit countries. Countries with which the IEA seeks enhanced engagement including Accession countries Chile and Mexico, Association countries China, India, Indonesia, Morocco, and Singapore. Co-operation with these and other partner countries cover a wide range of activities, from joint workshops to in-depth surveys of specific energy sectors or data exchange. Combined, the IEA co-operates with more than 69 countries worldwide.

IEA Energy Technology Network

The IEA Energy Technology Network is an ever-expanding, co-operative group of more than 6,000 experts that support and encourage global technology collaboration. At the head of this vast network is the Committee on Energy Research and Technology (CERT).

Committee on Energy Research and Technology

Comprised of senior experts from IEA member governments, the Committee on Energy Research and Technology (CERT) considers effective energy technology and policies to improve energy security, encourage environmental protection and maintain economic growth. Under the guidance of the IEA Governing Board, the CERT oversees the technology forecasting, analyses and the research, development, demonstration and deployment (RDD&D) strategies of the IEA Secretariat, notably through its flagship publication, *Energy Technology Perspectives*, and the series of energy technology roadmaps. The CERT also provides guidance to its working parties and experts' groups to examine topics that address current energy technology, or technology policy, issues. Four topical working parties support the work of the CERT, including the Fusion Power Co-ordinating Committee (FPCC).

Fusion Power Co-ordinating Committee (FPCC)

Created by the IEA Governing Board in 1975, the objective of the FPCC is to enhance fusion research, development, demonstration and deployment (RDD&D) activities with a strategic approach to realising fusion energy in both IEA member countries and key Partner countries. The FPCC accomplishes this objective by promoting, initiating and co-ordinating international co-operation on fusion carried out under the fusion Implementing Agreements.

[1] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea (Republic of), Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States; The European Commission also participates in the work of the IEA.

DEVELOPMENTS IN MATERIALS RESEARCH FOR FUSION

Rationale

Materials able to withstand extreme conditions are key research challenges for fusion, as materials in the fusion chamber will be exposed to unprecedented levels of heat fluctuations and/or high-energy neutron bombardment. For this reason, advancing materials research is a recurring strategic objective of the FPCC.

In 2015, the FPCC held a strategic session (seminar) on Advancing Materials Research for Power Generation. The event led to the following key messages:

- The diverging priorities between longer-term, research-driven materials science and the near-term needs of technologies for devices and systems.
- The limitations of current fusion testing facilities.
- The need to refine modelling tools to develop materials faster with the added advantage of being applicable to multiple use.
- The need to redouble R&D efforts on materials that are cost-effective, practical for purpose and most importantly, which could survive in extreme environments such as fusion.

The FPCC Strategic Plan 2018-2020 aims to accelerate knowledge transfer between fusion devices and joint programs by highlighting and examining cross-cutting issues, including materials for structural and plasma facing components.

This workshop provides an opportunity to review the strategies, recent developments and remaining challenges of research on fusion materials in among key research programmes worldwide. A number of key developments since January 2015 are worth examining:

- **Testing:** Progress with the International Fusion Materials Irradiation facility (IFMIF) and the engineering studies and site selection for building the DEMO Oriented Neutron Source (DONES). Recent approval for the construction of the Divertor Tokamak Test Facility (DTT) will test heat removal configurations including liquid metals.
- **Facilities:** Progress in the construction of ITER, operation of several new large facilities worldwide and new projects in the field of fusion material testing.
- **New concepts:** Design and planning for the Chinese Fusion Engineering Test Reactor (CFETR), an innovative concept and the proliferation of experimental and theoretical fusion research funded by the private sector.
- **Simulation and modelling:** Establishment of Mission Innovation, an initiative aiming at doubling R&D spending on clean energy, including materials through next-generation computing, artificial intelligence (machine learning), and robotics tools, as well as recent modelling results.

Aims

This workshop aims to answer the following:

- Understanding the key challenges, obstacles and risks
- Identifying current research strategies and priorities
- Reviewing the insights possible through simulation and modelling

AGENDA

08:30 Security clearance and registration

All talks should allow 10 minutes for discussion

9:00	1	**Welcome and opening remarks** *Jean Jacquinot, FPCC Chair*
9:05	2	**State-of-the-art of materials research for fusion** *Richard J. Kurtz, Chair, IEA Technology Collaboration Programme on Fusion Materials (FM TCP)*
9:30	2	**Europe: Strategies, recent developments and remaining challenges** *Tony DONNÉ, Programme Manager, EUROFusion*
10:00	3	**Japan: Strategies, recent developments and remaining challenges** *Hiroyasu TANIGAWA, Researcher, Structural Materials Development Group, Fusion Reactor Materials Research, Rokkasho Fusion Institute, Fusion Energy R&D, National Institutes for Quantum and Radiological Science and Technology (QST)*
10:30		*Coffee break*
10:45	4	**China: Strategies, recent developments and remaining challenges** *Yugang WANG, Deputy Dean, School of Physics, Peking University*
11:15	5	**United States: Strategies, recent developments and remaining challenges** *Yutai KATOH, Head of Fusion Materials programme, Oak Ridge National Laboratory, United States Department of Energy*
12:00	6	**Mission Innovation: Clean Energy Materials Innovation Challenge** *Mark KOZDRAS, Programme Manager, Materials for Transportation, National Resources Canada*
12:30	7	**Moderated discussion** *Jean Jacquinot, FPCC Chair*
13:00		**Session close**
13:00		*Lunch (self-catering)*

SPEAKERS AND MODERATORS

Richard J. Kurtz is a Laboratory Fellow in the Reactor Materials and Mechanical Design Group at the Pacific Northwest National Laboratory. He leads a large, multidisciplinary program to develop advanced, radiation-tolerant, low-activation materials for fusion power plants. He also directs technical activities in alloy development, performance of neutron irradiation experiments, post-irradiation evaluation of mechanical and physical properties, characterization of microstructure, and computer simulations to model and predict damage evolution. Previously his research focused on structural materials performance in nuclear power reactor components. He holds a PhD in Materials Science (Washington State University).

Tony DONNÉ, the Programme Manager at EUROFusion, has contributed expertise to development of diagnostics for ITER for more than 20 years and has been a member of several ITER and European Fusion Committees. Previously he was head of the Fusion Programme at the Dutch Institute for Fundamental Energy Research (DIFFER) and professor for Diagnostics of Fusion Plasmas (Eindhoven University of Technology). He also served as the Director of the Dutch-Russian Centre-of-Excellence on Fusion Physics and Technology, involving DIFFER and Russian institutes (Ioffe, Kurchatov and Triniti and the the Institute for Applied Physics). Earlier he led fusion physics research at the FOM Institute for Plasma Physics Rijnhuizen. While at Forschungszentrum Jülich he was head of the diagnostics group for the TEXTOR device. He obtained his PhD in physics at the Free University of Amsterdam

Hiroyasu TANIGAWA is a researcher in the Structural Materials Development Group, Fusion Reactor Materials Research, at the Rokkasho Fusion Institute, Fusion Energy R&D of the National Institutes for Quantum and Radiological Science and Technology (QST). He currently leads several technical working groups, including the reduced activation ferritic/martensitic steels within the IEA Technology Collaboration Programme on Fusion Materials (FM TCP); materials engineering for the DEMO Blanket for the DEMO R&D for the IFERC Project under Broader Approach activity; and the joint working group QST-US Department of Energy (testing first wall and blanket structural materials with mixed spectrum fission reactors). Dr. Tanigawa received the 2007 Miya Abdou FNT Award to recognise his outstanding technical contributions to fusion structural materials and blanket engineering. He holds a Master of Science (University of Tokyo) and earned a doctorate in nuclear power engineering (Kyoto University).

Yugang WANG is a Boya Distinguished Professor and the Deputy Dean at School of Physics, Peking University. He is also the Convener of Fusion Material Roadmap Group of China; Vice President, Chinese Association of Radiation Physics and Chinese Association of Radiation Effects. He is a Member of the International Committee of Radiation Effects in Insulators and of the OECD Nuclear Energy Agency Expert Group on Innovative Structural Materials. His research interests focus on investigating mechanisms of irradiation damage of the energetic particles on solids, especially on nuclear materials and nano-structured materials, such as MAX phases (a ternary laminar metal ceramics), nano-grain steels and high-entropy-alloys. He holds a PhD in nuclear physics (Peking University).

Yutai KATOH, a Distinguished Research Staff member of Oak Ridge National Laboratory, is Program Manager of the largest U.S. Fusion Materials Science program for the U.S. Department of Energy, Office of Fusion Energy Sciences. His research interests range from the fundamental physics of defects in solids to processing and application of advanced materials to qualification of new materials for nuclear applications. He has published more than 300 peer-reviewed journal articles in nuclear materials science and engineering with more than 10,000 citations. He is a Fellow of the American Ceramic Society and the American Nuclear Society. Katoh has a PhD in Materials Science (University of Tokyo).

Mark KOZDRAS is the Programme Manager, Materials for Transportation, National Resources Canada. Mark has extensive experience materials R&D, and process and product engineering at Dana Canada. His research on Dana's proprietary brazing process for aluminum heat exchanger production involved key contributions to novel plating and brazing process technologies. He has also been directly involved in lightweight materials research and, more recently, in the development of catalytic materials. He is the co-lead of Mission Innovation, Innovation Challenge 6: Clean Energy Materials and represents Canada in the TCP on Advanced Materials for Transportation. He is a Professional Engineer in Ontario and has been a long-standing member of ASM International and the Society of Automotive Engineers (SAE). He holds diplomas in Mechanical Engineering (University of Waterloo), specializing in materials and manufacturing.

CENTRE DE CONFÉRENCE MINISTÉRIEL (CCM)

http://convention-s.fr/lieux/ministere-des-affaires-etrangeres-centre-de-conference-ministeriel/

27, rue de la Convention, 75015 Paris

TRANSPORT

ARRIVING IN PARIS

Airport

Consult transport options from Charles de Gaulle (CDG)/Roissy (north) or Orly (south) airports on the Paris airports website (https://www.parisaeroport.fr/en/passengers/access/).

Train

All major train stations are directly linked to the Paris subway (metro) and bus lines operated by RATP (see below).

TRANSPORT WITHIN PARIS

Subway (metro), buses and trams

Consult the RATP website (https://www.ratp.fr/en/) for the itinerary from your hotel to the venue. Several stations are located near the venue:

Line	Station
Suburban train (RER) C: the RER C has many forks so *only take trains with names beginning with 'S' or 'V' or 'B' (e.g. Sara, Vick, Bolo)*	Javel
Subway/metro: line 10	Javel
Bus: line 42	Convention
Bus: line 62	Convention

Bicycle hire network (Velib)

Consult the Velib website for short-term subscription options (https://www.velib-metropole.fr/en_GB). Allow extra time for the pick-up (to understand the process) and drop-off (as a docking point may already be full). The docking points nearest the venue are:

Velib docking stations
#15064 Javel - André Citroen
#15063 Convention - Saint-Charles

SECURITY AND REGISTRATION

Please arrive **at least 30 minutes in advance** of the start of your meeting to allow sufficient time for security and registration formalities.

Before entering the gate you will need to show **photo identification such as a passport**. Once inside you will go through a security clearance.

Walk up the ramp to the main building entrance and present your photo ID to an IEA staff at the Reception desk to register and **obtain your visitor's badge**. For security, please wear your badge at all times.

Presentations will be available on the IEA website following the event at
https://www.iea.org/workshops/xxxxxxxx

For further information about the Fusion Power Co-ordinating committee, see
https://www.iea.org/about/structure/cert/fpcc/

Photo courtesy of the Oka Ridge National Laboratory, United States Department of Energy.