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ICMC Awards

ICMC LIFETIME ACHIEVEMENT AWARD 2023

David Evans

Rutherford Appleton Laboratory and
Advanced Cryogenic Materials Ltd.
United Kingdom

Prof. Xavier Obradors

Institut de Ciència de Materials de Barcelona
(ICMAB-CSIC) and Royal Academy of
Sciences and Arts of Barcelona (RACAB)
Spain

ICMC has presented its Award for Lifetime Achievement, typically biannually, at the CEC/ICMC conference since its 30th anniversary conference in Keystone in 2005 to an individual to "recognize a lifetime's achievement in advancing the knowledge of cryogenic materials".

The eleventh and twelfth recipients of the ICMC Lifetime Achievement Award are David Evans and Xavier Obradors, who follow Edward W. Collings in 2005, David C. Larbalestier in 2007, Kyoji Tachikawa in 2009, René Flükiger in 2011, Harold Weber in 2013, Herbert Freyhardt in 2015, Kozo Osamura in 2017, Archie Campbell in 2018, Teruo Matsushita in 2019, and Shi Xue Dou in 2021.

DAVID EVANS

Dave Evans has been evaluating, developing, and deploying cryogenic materials beginning in 1967 at the Rutherford Appleton National Laboratory after he earned a degree in chemistry at the University of North London. He has continued actively working on cryogenic materials after retiring in 2001 through his consulting company Advanced Cryogenic Materials Ltd.

He is known internationally for developing, characterizing, and using non-metallic materials and structures for cryogenic applications. He worked on projects around the world (European Union, United States, Japan, Russia, Korea, and China) and established a technical reputation for the selection, design, testing, and low-temperature employment of epoxy resins, glass-reinforced/epoxy composite laminates, radiation-resistant composite insulation, and vacuum-pressure resin impregnation of large-scale magnets. Evans was one of the pioneers in developing and characterizing low-temperature epoxy resin systems for use in resin impregnation and electrical insulation for high-energy physics magnets.

One aspect of his knowledge was of the low-temperature radiation resistance of organic materials, from his research on the effects that thermal and fast neutrons have on the mechanical properties, swelling, gas emission, and permeability of the organic epoxies. These radiation studies were

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done at room and cryogenic temperatures with different dosages to understand the effects that the cross-linking in the epoxy polymer chains had on gas evolution and fracture (chain scission).

The knowledge he developed about epoxy systems directly contributed to building successful magnets around the world, including at DESY, CERN, and ITER. For example, Evans was part of a team (including Richard Reed, Paul Fabian, and Paul Clark) that developed and characterized a low viscosity epoxy system for large superconducting magnets that was used for the ITER central solenoid (CS). They developed a vacuum polymer impregnation (VPI) system to outgas the magnet and resin components, and then inject, gel, and cure the resin in the ITER CS Model Coil (MC) and CS Modules with virtually no defects. At the time, the CS MC established a world record for injecting more than 300 gallons of resin in the coil.

Over the years Evans amassed an encyclopedic understanding of epoxy systems that he generously shared with colleagues. This included such things as expiration of the epoxy components, acceptable tolerances on the mixes, temperatures, and pressures, insulation drying in the mold, and acceptable outgassing rates in the insulation before transferring the resin into the mold. This information is critical for successful applications. A colleague described his kindness, humbleness, generosity and willingness to share his immense accumulated knowledge about composite behavior at cryogenic conditions as a precious gift for his colleagues and for many industries around the world.

Citation for Evans's award: In recognition of his domestic and international contributions developing, characterizing, and using non-metallic materials and structures for a wide variety of cryogenic applications.

XAVIER OBRADORS

Xavier Obradors earned a PhD in Physics from the University of Barcelona in 1982 and has been active in superconductivity since high-temperature superconductors were discovered. He is a Research Professor, Director of the the Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), and a member of the Royal Academy of Sciences and Arts of Barcelona (RACAB) Spain.

Early on Obradors investigated high-temperature superconductors growing single domain YBCO crystals using the Bridgman and the top-seeded pellet techniques. He focused on understanding vortex pinning with respect to the defect structure in these materials and also worked on their applications for fault current limiters, magnetic levitation, and motor applications.

Obradors shifted his focus to REBCO coated conductors (CC) made by the chemical solution deposition (CSD) technique. His group at ICMAB-CSIC has focused on developing this inexpensive technique using innovative approaches to study all aspects related to CSD. These include establishing CSD routes to fabricate all the buffer layers and the REBCO layer, deconvoluting the epitaxial REBCO growth mechanism, generating flux pinning nanocomposites using spontaneous segregation or multi-functional colloidal solutions, and understanding nanoscale defect structures and their relation to vortex pinning. Again, he has pursued practical application of the CCs in fault current limiters and for high field magnets. Recently they are studying ultrafast CSD growth of REBCO CCs, which is critical to reduce the production cost of YBCO to better enable many commercial applications.

A strength of the REBCO studies has been using transmission electron studies to deconstruct the many types of vortex pinning present in the highly engineered films into strong and weak pinning and isotropic and oriented defects. This way of thinking about the various types of pinning defects that are deliberately or otherwise introduced into the REBCO films has been enormously productive. Their TEM studies have found strong evidence for oxygen vacancy pinning (weak and isotropic) whose density correlates well with the strain deduced from x-ray measurements.

A colleague wrote that "Obradors has a knack for being able to provide insightful criticism, both positive and negative, in a very positive way. I am sure that such qualities, in addition to his technical capabilities, contribute to why he has been such a valued European project leader."

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Citation for Obradors's award: In recognition of his early studies on bulk melt-textured REBCO and recent studies of chemical solution deposition of REBCO coated conductors, focusing on the underlying materials science and developing them for practical applications.

ICMC CRYOGENIC MATERIALS AWARD FOR EXCELLENCE 2023

Dr. Shreyas Balachandran
Thomas Jefferson National Accelerator Facility
Newport News, VA

The ICMC Cryogenic Materials Award for Excellence is awarded annually at the ICMC Conference, subject to the nomination of an appropriate candidate, to an individual, who is under 40 years of age by the application deadline, to "recognize excellence in advancing the knowledge of cryogenic materials over recent years". The 2023 award was given to Shreyas Balachandran. Previous awardees are Fumitake Kametani in 2014, Kazumasa Iida in 2016, Tengming Shen in 2017, Anna Kario and Akiyasu Yamamoto in 2018, Kohei Higashikawa in 2019, Dongliang Wang in 2020, and Mark Ainslie in 2021.

Shreyas Balachandran has worked on a variety of cryogenic materials since earning his PhD from Texas A&M University in 2015. These include metals for cryogenic applications, Nb for superconducting radio frequency (SRF) cavities, and Nb_3Sn. After earning his PhD, he moved to the Applied Superconductivity Center (ASC) at the National High Magnetic Field Laboratory (NHMFL) starting as a Postdoctoral Fellow and then becoming a Visiting Research Faculty. He recently moved to Thomas Jefferson National Accelerator Facility where he is an SRF Materials Scientist.

Some of his first studies at the NHMFL evaluated metals for cryogenic applications where he helped identify a failure mode in an aluminum forging used to encase dipole magnets at CERN.

He made a notable impact on SRF cavities by showing direct evidence for the relationship between Nb grain size and undesirable flux-trapping in SRF cavities. He found that Nb grains that were sub-50 μm trapped flux preferentially compared to regions with larger grain size. Understanding this required comprehensive analysis of the local microstructural and microchemical states in the Nb. He applied his metallurgical skill-set to bring new insights to the field that generated important collaborations with industrial partners and with Jefferson Lab and CERN. An industrial collaborator remarked that Balachandran does fundamental science that has engineering consequences.

His research also significantly impacted Nb_3Sn, with additions of 1% Hf (in Nb4Ta1Hf) increasing its $H_{C2}(0)$ to 31 T. He also found that adding 1% Hf and similarly adding 1% Zr (in Nb4Ta1Zr) increased the recrystallization temperature of the Nb alloy above the Nb_3Sn formation temperature, which allowed dense nucleation of Nb_3Sn in the Nb alloy grain boundaries, resulting in much finer Nb_3Sn grains (60-80 nm) and correspondingly higher J_C. For the paper describing this work, he received the Jan Evetts Award from *Superconducting Science and Technology* for the best paper by a young scientist less than 10 years from his PhD.

A colleague remarked that he is a particularly good mentor and teacher saying that he can explain highly technical topics at the level a student or coworker needs it to be, to be understood and he is a motivator who helps students and co-workers get excited about their projects.

Citation for Balachandran's award: For significant contributions to the understanding of flux trapping issues in Nb SRF cavities and the impact of ternary and quaternary alloys for improving Nb_3Sn conductors.

ICMC BEST PAPER AWARDS

The ICMC Best Paper Awards provide an incentive for the production and presentation of high-quality papers at the International Cryogenic Materials Conferences and recognition of authors who, in the judgment of the ICMC Board of Directors, presented the best paper at the preceding conference. Papers are nominated by the reviewers.

In 2023, the award for the best paper delivered at the 2021 Virtual ICMC, and published in the *IOP Conference Series: Materials Science and Engineering, Vol. 1241, 2022*, was presented at the 2023 Honolulu conference to the following:

Best Structural Materials Paper

Y. Kunitoku, Y Akiyama, Y Manabe and F Sator

for their paper

"Study on Irradiation Effect of Insulating Materials for Fusion Superconducting Magnet: Effect of Low-temperature Irradiation"

IOP Conference Series: Materials Science and Engineering, Vol. 1241, 2022; 012004

ICMC STUDENT MERITORIOUS PAPER AWARD

The ICMC Board of Directors also recognizes students who write high quality papers. All students who applied for and participated in the ICMC Early Registration Fee Waiver program during the 2021 ICMC Virtual Conference were automatically entered for consideration of the ICMC Student Meritorious Paper Award. The papers are ranked on the basis of research merit and quality of writing.

In 2023, the award for the best Student Meritorious papers from the 2021 Virtual ICMC, and published in the *IOP Conference Series: Materials Science and Engineering, Vol. 1241, 2022*, were presented at the 2023 Honolulu conference to the following:

Srikar Telikapalli, Robert M. Swain, Peter Cheetham, Chul H. Kim, and Sastry V. Pamidi

for their paper
"Electric Aircraft Fueled by Liquid Hydrogen and Liquefied Natural Gas"
IOP Conference Series: Materials Science and Engineering, Vol. 1241, 2022; 012035

And

Victor Ogunjimi, Mary Ann Sebastian, Di Zhang, Bibek Gautam, Jie Jian, Jijie Huang, Yifan Zhang, Timothy Haugan, Hiyan Wang, and Judy Wu

for their paper
"Interface Engineering for Enhanced Magnetic Vortex Pinning by 1D-BZO APCs in a Wide Angular Range"
IOP Conference Series: Materials Science and Engineering, Vol. 1241, 2022; 012022