



## CRITICAL RAW MATERIAL ELECTROCATALYSTS REPLACEMENT ENABLING DESIGNED POST-2020 PEMFC

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### DELIVERABLE REPORT

<b>DELIVERABLE 7.4 – ORGANISATION OF AN INTERNATIONAL CONFERENCE “CHALLENGES FOR ZERO PLATINUM FOR OXYGEN REDUCTION AND HYDROGEN OXIDATION”</b>		
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<b>NATURE OF THE DELIVERABLE</b>		
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<b>SUMMARY</b>	
<b>Keywords</b>	EFCD2019 - Electrolysis and Fuel Cell Discussions conference, Towards Catalyst Free of Critical raw Materials for Fuel Cells and Electrolysers
<b>Abstract</b>	<p>CRESCENDO jointly organised with the H2020 CREATE project (<a href="http://www.create-h2020energy.eu">http://www.create-h2020energy.eu</a>) the second edition of the Electrolysis and Fuel Cell Discussions conference, EFCD2019, dedicated to catalysts with minimum amount of Critical Raw Materials, and in particular of Platinum Group Metals.</p> <p>This highly successful international conference was held at La Grande Motte in France, 15-18 September 2019. Attended by 160 international participants, it provided the opportunity to apprise the state of the art, showcase CRESCENDO and CREATE results and interact with other FCH-JU/H2020 funded projects, including PEGASUS, which was invited to share a special session.</p>
<b>Public abstract</b>	<i>Same as above</i>

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# ORGANISATION OF AN INTERNATIONAL CONFERENCE “CHALLENGES FOR ZERO PLATINUM FOR OXYGEN REDUCTION AND HYDROGEN OXIDATION

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## 1. SCOPE

This deliverable report describes the International Conference jointly organised by CRESCENDO and CREATE project (partners CNRS and PXO) "Towards Catalyst Free of Critical raw Materials for Fuel Cells and Electrolysers". The website for the conference may be found at <http://www.efcd2019.eu/>, see the screenshot below.

**2019 EFCD**

*Electrolysis and Fuel Cell Discussions*  
 Towards Catalysts Free of Critical Raw  
 Materials for Fuel Cells and Electrolysers

*15-18 September 2019*  
*La Grande Motte, France*

VENUE    AUDITORIUM    HOTEL    BEACH    HARBOR

**WELCOME TO EFCD2019**

Following the success of EFCD2015 - Electrolysis and Fuel Cell Discussions, Challenges Towards Zero Platinum for Oxygen Reduction - in 2015, the Electrolysis and Fuel Cell Discussions conference in 2019 is dedicated to catalysts with minimum amount of Critical Raw Materials, and in particular of Platinum Group Metals.

Catalysis of the oxygen reduction and hydrogen oxidation reaction in fuel cells leaning on either proton-exchange or anion-exchange membranes is a key for enabling their large-scale deployment. Similarly, catalysis of the oxygen and hydrogen evolution reactions is key for electrolyzers with polymer-based electrolytes.

This conference is the opportunity to present recent results in the field and to discuss the scientific and technological challenges on the way towards zero platinum. Invited lectures, oral and poster presentations will provide an international perspective of the most recent research activities in this

**Conference Chairs**

*Dr. Deborah Jones*  
*Dr. Frédéric Jaouen*  
 CNRS Montpellier, France

## 2. DESCRIPTION OF THE CONFERENCE

This second edition of the conference under the banner Electrolysis & Fuel Cell Discussions was held at the Palais des Congrès in La Grande Motte. It focused on ultralow platinum catalysts (and catalyst layers) and catalysts free of critical raw material for fuel cells and electrolyzers.

The meeting attracted 160 participants from 24 different countries. Most participants came from Europe (80 %), the largest representation being from France, followed by Germany. Industry was well represented with 17 participants from the automotive or chemical industry and OEMs.

The most recent advances in the field were reported in 10 invited communications, 34 oral communications and more than 80 poster presentations. The invited speakers included Dr Piotr Zelenay (Los Alamos National Lab., USA) of the US ElectroCat consortium and Dr Alexey Serov, from Pajarito Powder LLC, the only company to commercialise PGM-free catalysts at the present time. The complete list of invited speakers is given below.

Lior Elbaz, Bar Ilan University, Israel  
Akimitsu, Ishihara, Yokohama National University, Japan  
Alex Martinez Bonastre, Johnson Matthey, United Kingdom  
William Mustain, University of South Carolina, USA  
Peter Pintauro, Vanderbilt University, USA  
Bryan Pivovar, National Renewable Energy Laboratory, USA  
Alexey Serov, Pajarito Powder LLC, USA  
Peter Strasser, Technical University Berlin, Germany  
Piotr Zelenay, Los Alamos National Laboratory, USA  
Iryna Zenyuk, University of California Irvine, USA

The meeting was organised in a single session, typically alternating between presentations on low PGM and non-PGM catalysts in alkaline and acid media during the four sub-sessions run every day. The key issues including new catalyst development and characterisation, development of characterisation methodologies in particular for active site and turnover frequency determination for PGM-free catalysts, and catalyst layer development with non-PGM catalysts were all addressed, as well as the crucial question of durability and catalyst ageing mechanisms. Lunches in the Palais des Congrès just a minute away from the conference room offered an excellent place for discussions.

The conference started with a welcome buffet reception and the first poster session on Sunday evening. On Monday morning, after the conference opening, the first invited talk was given by Professor Peter Strasser from Technical university of Berlin (CRESCENDO partner), who focussed his lecture on the development of methodologies for active site determination in PGM-free catalysts. Three invited talks given by university or research institute scientists followed on Monday, on either low PGM or non-PGM catalysts for oxygen reduction, but also on low PGM catalysts for oxygen evolution. The second poster session was held on Monday evening. Tuesday morning was dedicated to the presentation of three projects – CRESCENDO, CREATE and PEGASUS - funded by the Fuel Cell and Hydrogen Joint Undertaking (FCH-JU) and the NMBP programme, a session open to all participants. In each case, a short overview of the project was followed by a focus presentation on one particularly successful or original aspect of the work. The three sessions following on Tuesday all included an invited lecture. After a late afternoon break, all participants gathered for the conference dinner on the beach side, which was much enjoyed.

On Wednesday the three poster prizes were awarded after lunch. The conference closed after a final invited talk given by Professor Peter Pintauro.

Project partners from CEA, University of Padua, Imperial College, Johnson Matthey and Technical University of Berlin, as well as CNRS and University of Montpellier, all attended and presented results from CRESCENDO, both orally and through posters, and, in the case of Alex Martinez Bonastre from JM, with an invited lecture.

### 3. CONFERENCE PROGRAMME

The conference oral and poster programmes follow:

#### ORAL PROGRAMME

##### SUNDAY 15 SEPTEMBER 2019

- 15:00 - 19:00 Registration desk open  
 19:00 - 21:00 *Welcome buffet & Poster session 1*

##### MONDAY 16 SEPTEMBER 2019

#### Topic 01 - Non-PGM and ultralow PGM CATALYSTS (for ORR, PEMFC)

- 08:45 - 09:00 **Conference opening**  
 Dr. Deborah Jones & Dr. Frédéric Jaouen
- 09:00 - 09:40 **Plenary**  
*PGM-poor and PGM-free ORR fuel cell electrocatalysts*  
**Peter Strasser**, Technical University of Berlin, Germany
- 09:40 - 10:00 **Oral**  
*How Small: Selecting the right size of Pt Nanoparticles to enhance Their Oxygen Electroreduction Mass Activity*  
**Batyr Garlyyev**, Technical University of Munich, Germany
- 10:00 - 10:20 **Oral**  
*Novel Double Passivation Galvanic Displacement Method for Production of High-Performance Pt-alloy Electrocatalysts*  
**Matija Gatalo**, National Institute of Chemistry, Slovenia
- 10:20 - 10:40 **Oral**  
*Pd<sub>3</sub>Y alloyed NPs prepared by Laser Ablation: towards zero platinum in PEMFC cathode catalysts*  
**Riccardo Brandiele**, University of Padova, Italy
- 10:40 - 11:00 **Coffee Break**
- 11:00 - 11:40 **Plenary**  
*Platinum Group Metal-Free Catalysts for Oxygen Reduction: State of the Art, Mechanistic Insights, and Challenges*  
**Piotr Zelenay**, Los Alamos National Laboratory, Los Alamos NM, USA
- 11:40 - 12:00 **Oral**  
*Active-site imprinting: Template ion reactions towards tailored Fe-N-C electrocatalysts*  
**Tim-Patrick Fellingner**, Technical University of Munich, Germany
- 12:00 - 12:20 **Oral**  
*What core@shell model studies can teach us about electrocatalysis?*  
**Gaetano Granozzi**, University of Padova, Italy

<b>12:20 - 14:00</b>	<b>Lunch Break</b>
	<b>Topic 02 - Catalysts for anion-exchange membrane fuel cells</b>
<b>14:00 - 14:40</b>	<b>Plenary</b> <i>New Catalysts and Electrode Designs for High Power, Long-Life AEMFCs</i> <b>William Mustain</b> , University of South Carolina, USA
<b>14:40 - 15:20</b>	<b>Plenary</b> <i>Advances in Low and Pt-free loading in Anion Exchange Membrane Fuel Cells</i> <b>Bryan Pivovar</b> , National Renewable Energy Laboratory, USA
<b>15:20 - 15:40</b>	<b>Oral</b> <i>Iron and nitrogen doped carbide-derived carbon/carbon nanotube composite catalysts for fuel cell cathodes</i> <b>Kaido Tammeveski</b> , University of Tartu, Estonia
<b>15:40 - 16:00</b>	<b>Oral</b> <i>Non-Precious Metal Nitrides as Novel Electrocatalyst for Enhanced Hydrogen Oxidation Reaction</i> <b>Vineesh Thazhe Veettil</b> , Bar Ilan University, Israel
<b>16:00 - 16:20</b>	<b>Coffee Break</b>
	<b>Topic 03 - Catalysts for anion- exchange membrane electrolyzers</b>
<b>16:20 - 16:40</b>	<b>Oral</b> <i>High performance anion exchange membrane electrolysis using plasma-sprayed, non-precious metal electrodes</i> <b>Andreas Friedrich</b> , German Aerospace Center (DLR), Germany
<b>16:40 - 17:00</b>	<b>Oral</b> <i>Direct electrolysis of lignin in a continuous-flow Polymer Electrolyte Membrane reactor</i> <b>Angel Caravaca</b> , IRCELYON-CNRS, France
<b>17:00 - 17:20</b>	<b>Oral</b> <i>Water Dissociation Catalysis</i> <b>Sebastian Oener</b> , University of Oregon, USA
<b>17:20 - 17:40</b>	<b>Oral</b> <i>Degradation Mechanisms of Manganese Oxide Electrocatalysts - Guidelines for Alkaline Energy Conversion Devices</i> <b>Florian Speck</b> , Forschungszentrum Jülich GmbH, Germany
<b>17:40 - 18:00</b>	<b>Oral</b> <i>Soft X-ray Absorption Spectroscopy and Resonant Inelastic X-Ray Scattering as in situ Characterisation Tools for 3d Transition Metal Based Catalysts for OER</i> <b>Marc Frédéric Tesch</b> , Max Planck Institute for Chemical Energy Conversion, Germany
<b>18:00 - 19:00</b>	<b>Break</b>
<b>19:00 - 21:00</b>	<b>Poster session 2 and reception</b>

## TUESDAY 17 SEPTEMBER 2019

### H2020 FCH-JU session

- 09:00 - 09:15**      **Oral**  
*CRESCENDO project Overview*  
**Deborah Jones**, CNRS Montpellier, France
- 09:15 - 09:35**      **Oral**  
*Increasing population of oxygen reduction active sites in Fe-N/C catalysts*  
**Asad Mehmood**, Imperial College of London, United Kingdom
- 09:35 - 09:50**      **Oral**  
*CREATE project Overview*  
**Frédéric Jaouen**, CNRS Montpellier, France
- 09:50 - 10:10**      **Oral**  
*Novel strategies to enhance OER electrocatalysis in alkaline media*  
**Jose Ramon Galan-Mascaros**, Institute of Chemical Research of Tarragona (ICIQ), Spain
- 10:10 - 10:25**      **Oral**  
*PEGASUS project Overview*  
**Pierre-André Jacques**, CEA Grenoble, France
- 10:25 - 10:45**      **Oral**  
*Synthesis and characterization of Fe-N-C aerogel catalysts for oxygen reduction reaction*  
**Sandrine Berthon-Fabry**, MINES Paristech / PERSEE, France
- 10:45 - 11:00**      *Coffee Break*
- 11:00 - 11:40**      **Plenary**  
*The labyrinth around low PGM fuel cells for the electrification of the power train*  
**Alex Martinez Bonastre**, Johnson Matthey PLC, United Kingdom
- 11:40 - 12:00**      **Oral**  
*Resistances in low-Pt-loaded catalyst layers from a mass transport and ionomer point of view*  
**Adam Weber**, Lawrence Berkeley National Laboratory, USA
- 12:00 - 12:20**      **Oral**  
*Measurement of oxygen transport resistance of precious metal-free (PGM-free) catalyst layers in PEMFC*  
**Yang-Shen Li**, Technical University of Munich, Germany
- 12:20 - 14:00**      *Lunch Break*



### Topic 06 - Advanced characterisation techniques

14:00 - 14:40

#### Plenary

*Understanding Pyrolysis of PGM-free Electrocatalysts with Micro- and Nano-Synchrotron X-ray Computed Tomography*

**Iryna Zenyuk**, University of California Irvine, USA

14:40 - 15:00

#### Oral

*Insights into the Pyrolysis of Fe-N-C Electrocatalysts using High Temperature XAFS*

**Stephen Lyth**, Kyushu University, Japan

15:00 - 15:20

#### Oral

*Revealing the mechanism of active site formation in Metal-Nitrogen-Carbon catalysts*

**Andrea Zitolo**, Synchrotron SOLEIL, France

15:20 - 15:40

#### Oral

*X-ray Emission Spectroscopy Insights into the Spin State of Iron in Fe/N/C Catalysts*

**Kathrin Ebner**, Paul Scherrer Institut, Switzerland

15:40 - 16:00

#### Oral

*Quantum Chemical Investigation of Spectroscopic Properties of Fe-N-C model catalysts*

**Charlotte Gallenkamp**, TU Darmstadt, Germany

16:00 - 16:20

#### Coffee Break

### Topic 03 - Catalysts for proton-exchange membrane electrolyzers

16:20 - 16:40

#### Oral

*Multi-Component Ni-Ir Electrocatalysts toward Efficient Oxygen Evolution Reaction*

**Meital Shviro**, Forschungszentrum Jülich GmbH, Germany

16:40 - 17:00

#### Oral

*Spray-dried, Ultraporous Ir-based Catalyst for Proton Exchange Membrane Water Electrolyser*

**Jennifer Péron**, Université Paris Diderot, France

17:00 - 17:20

#### Oral

*Performance of [Mo<sub>3</sub>S<sub>13</sub>]<sup>2-</sup> nanoclusters based cathodes in PEM water electrolysis – loading variation*

**Peter Holzapfel**, Forschungszentrum Jülich GmbH, Germany

17:20 - 17:40

#### Oral

*The Stability of Atomically Dispersed Pt Electrocatalyst*

**Michel Paul**, Forschungszentrum Jülich GmbH, Germany

17:40 - 18:00

#### Oral

*Operando X-ray Characterization of High Surface Area Iridium Oxides to Decouple their Activity Losses for the Oxygen Evolution Reaction*

**Juan Herranz**, Paul Scherrer Institut, Switzerland

18:00 - 19:15

#### Break

19:30 -

#### Conference Dinner

**WEDNESDAY 18 SEPTEMBER 2019**
**Topic 01, non-PGM and ultralow PGM Catalysts**
**09:00 - 09:40**
**Plenary**

*Recent Advances in the Design of PGM-free Catalysts: From Molecular Catalysts to the State-of-the-Art Heat-Treated Atomically Dispersed Catalysts*

**Lior Elbaz**, Bar Ilan University, Israel

**09:40 - 10:00**
**Oral**

*Designing M–N/C Electrocatalysts with Preferentially Generated M–Nx Sites for Efficient Energy Conversion Electrocatalysis*

**Sang-Hoon Joo**, UNIST, Republic of Korea

**10:00 - 10:20**
**Oral**

*Effect of Partial Oxygen Pressure of Pt/Nb-SnO<sub>2</sub> Cathode Catalyst Layers on Load Cycle Durability for Polymer Electrolyte Fuel Cells*

**Makoto Uchida**, University of Yamanashi, Japan

**10:20 - 10:40**
**Oral**

*A Ti<sub>3</sub>O<sub>5</sub>Mo<sub>0.2</sub>Si<sub>0.4</sub>-based metal oxide support with enhanced conductivity and stability*

**Bradley Easton**, Ontario Tech University, USA

**10:40 - 11:00**

*Coffee Break*

**Topic 08 - Ageing and durability**
**11:00 - 11:40**
**Plenary**

*Are PGM-free Fuel Cell Catalysts Ready for Prime-Time?*

**Alexey Serov**, Pajarito Powders LLC, USA

**11:40 - 12:00**
**Oral**

*Atomically dispersed Fe-N-C active sites: chemistry, morphology, activity and stability insights*

**Plamen Atanassov**, University of California Irvine, USA

**12:00 - 12:20**
**Oral**

*Instability of Fe-N-C catalysts in acidic conditions*

**Chang Hyuck Choi**, GIST, Republic of Korea

**12:20 - 14:00**

*Lunch Break*

**14:00 - 14:40**
**Plenary**

*Oxygen Reduction Activity of Group 4 and 5 Oxide-Based Cathodes for Polymer Electrolyte Fuel Cells*

**Akimitsu Ishihara**, Yokohama National University, Japan

**14:40 - 15:00**
**Oral**

*Non-covalent integration of a Ni based molecular catalyst to graphene acid for efficient, noble-metal free, electrocatalytic H<sub>2</sub> oxidation*

**Bertrand Reuillard**, CEA Grenoble, France

**15:00 - 15:20**

*Coffee Break*

- 15:20 - 16:00**      **Plenary**  
*Recent Progress on Nanofiber Electrodes for Hydrogen/Air Fuel Cells*  
**Peter Pintauro**, Vanderbilt University, USA
- 16:00 - 16:20**      **Oral**  
*Low cost ZIF-8 metal organic frameworks as precursor for Fe/N/C oxygen reduction catalysts*  
**Carsten Cremers**, Fraunhofer Institute for Chemical Technology (ICT), Germany
- 16:20 - 16:30**      **Close of Conference**

## POSTER PROGRAMME

**Sunday 15 September 2019**

### Topic 01 - Non-PGM and ultra-low PGM catalysts – subtopic: Oxygen Reduction Reaction

<b>Bhandari</b>	Sabita	<i>Structural analysis of Pt in Pt/Fe-N-C catalyst for the oxygen reduction reaction in PEM fuel cells</i>	Max Planck Institute for Chemical Energy Conversion, Germany
<b>Danilov</b>	Michail	<i>Controlled Electrochemical Synthesis of the Partially Unzipped Multi-Wall Carbon Nanotubes for Electrodes of Fuel Cell</i>	National Academy of Science of Ukraine, Ukraine
<b>De Sá</b>	Maria Helena	<i>Passive direct methanol fuel cells as an alternative to the lithium batteries in portable applications: development of sustainable “eco-friendly” nanocatalysts</i>	Faculdade de Engenharia da Universidade do Porto, Portugal
<b>Durante</b>	Christian	<i>Converting mixed plastics into mesoporous Fe-N-C electrocatalyst active for oxygen reduction reaction in acidic electrolyte: the continuing challenge of active site formation and characterization</i>	University of Padova, Italy
<b>Easton</b>	E. Bradley	<i>Preparing model Fe-N/C active sites with molecular-level control</i>	Ontario Tech University, Canada
<b>Ebner</b>	Kathrin	<i>57Fe-enrichment effect on the composition and performance of Fe-based O<sub>2</sub>-reduction electrocatalysts</i>	Paul Scherrer Institut, Switzerland
<b>Friedman</b>	Ariel	<i>Achieving High Density of catalytic sites via Electropolymerization of Metallo Corroles</i>	Bar-Ilan University, Israel
<b>Hülstede</b>	Julia	<i>Biomass-Based Carbon Support for Non-Precious Metal ORR Catalysts</i>	DLR Institute of Networked Energy Systems, Germany

<b>Lagrichi</b>	Othman	<i>Platinum-Nickel Nanotubes Array as Cathode For PEMFC</i>	CEA Grenoble, France
<b>Lilloja</b>	Jaana	<i>Nitrogen-doped nanocarbons as catalysts for electroreduction of oxygen in alkaline solution</i>	Institute of Chemistry, University of Tartu, Estonia
<b>Parnière</b>	Alice	<i>Novel ORR electrocatalyst based on Pt-RE nanoparticles supported on nitrogen functionalised porous carbon</i>	ICGM-AIME, France
<b>Primbs</b>	Mathias	<i>Influence of carbon support modification on non-noble MNC catalyst for oxygen reduction reaction</i>	Technical University Berlin, Germany
<b>Rana</b>	Zahra	<i>Developing Low-Cost, M-N-C Electrocatalysts for the ORR in Low Temperature Fuel Cells</i>	University College London, United Kingdom
<b>Ratso</b>	Sander	<i>Fe-N-C catalysts prepared from carbide derived carbons for PEMFC cathodes</i>	Institute of Chemistry, University of Tartu, Estonia
<b>Rojas</b>	Sergio	<i>Effect of thermal treatment in the synthesis of Fe/N/C catalysts</i>	ICP-CSIC, Spain
<b>Rossetti</b>	Gabriele	<i>Towards stable and low-PGM fuel cell cathode with Hierarchical Nanostructured Thin Film (NSTF) as non-carbon support</i>	Istituto Italiano di Tecnologia, Italy
<b>Roy</b>	Aaron	<i>Atomically Dispersed Iron Nitrogen Carbon Catalysts with High Turnover Frequency for Oxygen Reduction Reaction in PEM Fuel Cells</i>	ICGM-AIME, France
<b>Saida</b>	Takahiro	<i>The Relationship between the Activity of Oxygen Reduction Reaction and the Distortion in Transition-metal Oxide Catalyst</i>	Meijo University, Japan
<b>Santori</b>	Pietro Giovanni	<i>Effect of Pyrolysis Atmosphere and Electrolyte pH on the Oxygen Reduction Activity, Stability and Spectroscopic Signature of Fe<sub>Nx</sub> Moieties in Fe-N-C Catalysts</i>	ICGM-AIME, France
<b>Sibul</b>	Roberta	<i>Iron containing and nitrogen-doped graphene-based catalysts for the fuel cell cathode</i>	University of Tartu, Estonia
<b>Sun</b>	Shuhui	<i>Non-PGM electrocatalysts for PEM fuel cells: Origin of their instability</i>	INRS-Énergie, Matériaux et Télécommunications (INRS-EMT), Canada

<b>Sun</b>	Yanyan	<i>Confined Pyrolysis Synthesis of Fe-Coordinated Nitrogen-Doped Carbon Catalysts with Surface-Rich Fe–Nx Moiety to Boost the Oxygen Reduction Reaction in Acidic Media</i>	Technical University Berlin, Germany
<b>Tasca</b>	Federico	<i>Oxygen Reduction Reaction at Fe Catalysts with 4 or 5 Coordinated N Atoms. Calculated and Experimental O<sub>2</sub>-Fe Binding Energy, Activity Indexes, Volcano Correlations</i>	Universidad de Santiago de Chile, Chile
<b>Yarova</b>	Svitlana	<i>NON-PGM metal-based Catalysts Based on MOFs and Electrospun Carbon Nanofibers</i>	ICGM-AIME, France
<b>Zagoraïou</b>	Eirini	Highly and atomically dispersed Pt supported catalysts – Effect of properties on the electrocatalytic activity	Institute of Chemical Engineering Sciences, FORTH-ICE/HT, Greece

### Topic 01 - Non-PGM and ultra-low PGM catalysts – subtopic: Hydrogen Oxidation Reaction

<b>Artero</b>	Vincent	<i>Performances of ionomer-containing bio-inspired hydrogen fuel cell anodes: an interplay between surface chemistry and self-assembly at the mesoscale</i>	Université Grenoble Alpes and CEA Grenoble, France
<b>Kitayev</b>	Anna	<i>Non-Platinum catalyst for Hydrogen Oxidation Reaction in AMFC</i>	Bar Ilan University, Isarel
<b>Novakova</b>	Jaroslava	<i>Atomically dispersed platinum in ceria matrix for PEMFC anode</i>	Charles University, Czech republic
<b>Wolf</b>	Sigrid	<i>Carbon supported ternary PdNiBi electrocatalysts for ethanol oxidation reaction in alkaline direct ethanol fuel cells</i>	Graz University of Technology, Austria

### Topic 02 - Catalysts for proton- or anion-exchange membrane fuel cells

<b>Blanchard</b>	Pierre-Yves	<i>Platinum Free Cathode: Development of a Chemically Regenerative Redox Fuel Cell</i>	ICGM-AIME, France
<b>Dionigi</b>	Fabio	<i>Ternary Pt alloy catalysts for low Pt loaded fuel cell cathodes</i>	Technische Universität Berlin, Germany
<b>Koyuturk</b>	Burak	<i>Degradation, activity vs. loading and reaction mechanism of a non-precious ORR catalyst for PEMFCs</i>	Technical University of Munich, Germany
<b>Li</b>	Jingkun	<i>Engineering the 3D architecture of non-precious metal cathodes for practical H<sub>2</sub>/air proton exchange membrane fuel cell applications</i>	ICGM-AIME, France

<b>Lorenz</b>	Julian	<i>Mesostructured Cobalt-Manganese-Oxides as Non-PGM Oxygen Reduction Catalyst in Anion Exchange Membrane Fuel Cells</i>	DLR Institute of Networked Energy Systems, Germany
<b>Ott</b>	Sebastian	<i>PGM-poor and PGM-free ORR fuel cell electrocatalysts</i>	Technical University of Berlin, Germany
<b>Pham</b>	Chuyen	<i>Performance of alkaline exchange membrane fuel cells using metal-free carbon based oxygen reduction catalysts</i>	University of Freiburg, Germany
<b>Roiron</b>	Camille	<i>Pt-free 3D-catalyst for proton exchange membrane fuel cells</i>	CEA Grenoble, France
<b>Rojas</b>	Sergio	<i>Fe/N/G catalysts for the ORR in acid electrolyte</i>	ICP-CSIC, Spain
<b>Teppor</b>	Patrick	<i>The influence of synthesis conditions to a facile Co-N/C type ORR catalyst synthesis method in RDE and fuel cell measurements</i>	University of Tartu, Estonia
<b>Yang</b>	Wonseok	<i>Performance analysis on ZIF-8 based non-PGM catalyst for oxygen reduction reaction in PEM fuel cells</i>	Korea University, Republic of Korea

## Monday 16 September 2019

### Topic 01 - Non-PGM and ultra-low PGM catalysts – subtopic: Oxygen Evolution Reaction

<b>Arriaga Hurtado</b>	Luis Gerardo	<i>Three-dimensionally ordered mesoporous material based on a trimetallic spinel (Mn<sub>0.5</sub>Ni<sub>0.5</sub>Co<sub>2</sub>O<sub>4</sub>) as oxygen bifunctional electrocatalyst</i>	Centro de investigación y desarrollo tecnológico en electroquímica, Mexico
<b>Dam</b>	An Phuc	<i>Exploring the Connection between Oxygen Evolution Reaction on Iridium Oxides and Catalyst Dissolution using Microkinetic Modelling</i>	Max-Planck Institute for Dynamics of Complex Technical Systems, Germany
<b>Habrioux</b>	Aurélien	<i>Noble metal-free catalysts for oxygen electrocatalysis in alkaline medium</i>	Institut de Chimie des Milieux et Matériaux de Poitiers, France
<b>Ham</b>	Kahyun	<i>The Role of Cation in Birnessite-like Mn Oxide toward Oxygen Evolution Reaction</i>	Gwangju Institute of Science and Technology, Republic of Korea
<b>Retuerto</b>	Maria	<i>ORR/OER Bifunctional Catalytic Activity of La<sub>1.5</sub>Sr<sub>0.5</sub>NiMn<sub>0.5</sub>Ru<sub>0.5</sub>O<sub>6</sub></i>	CSIC, Spain

<b>Retuerto</b>	Maria	<i>Na-doped Ruthenium Perovskites: Enhanced oxygen evolution activity and durability in acid media.</i>	CSIC, Spain
<b>Slavcheva</b>	Evelina	<i>Non-carbon supported Ni and Co catalysts for AEM water electrolysis</i>	Bulgarian Academy of Sciences, Bulgaria
<b>Thorbjørnsen</b>	Kristian Fredrik Klepp	<i>Iridium deposition by galvanic displacement of Cu in a one-pot configuration</i>	Norwegian University of Science and Technology, Norway

### Topic 01 - Non-PGM and ultra-low PGM catalysts – subtopic: Hydrogen Evolution Reaction (and CO<sub>2</sub> reduction)

<b>Ali</b>	Syed Muhammad Farhan	<i>Investigation of alloys of transition metals with PGMs towards hydrogen-reactions</i>	Aalto University, Finland
<b>Bagnall</b>	Andrew	<i>Molecular-engineered electrodes incorporating cobalt catalysts for hydrogen evolution</i>	Univ Grenoble Alpes and CEA Grenoble, France
<b>Dürr</b>	Robin	<i>Efficient and Raw Material Free HER Catalysts Based on Doped ZIF Structures in Strong Acidic and Basic Conditions and Improvement with Co<sub>2</sub>Mo<sub>3</sub>O<sub>8</sub> Nanostructures</i>	CEA Paris Saclay/ Université Paris Saclay, France
<b>Giuffredi</b>	Giorgio	<i>Mesoporous CuOx-derived Nanostructured Copper Catalysts for CO<sub>2</sub> Reduction</i>	Istituto Italiano di Tecnologia, Italy
<b>Giuffredi</b>	Giorgio	<i>Bioelectrochemical TiN FDH Catalyst for CO<sub>2</sub> Reduction to HCOOH</i>	Istituto Italiano di Tecnologia, Italy
<b>Giuffredi</b>	Giorgio	<i>Self-supported, short range ordered Molybdenum Sulfide as high current density non-PGM HER catalyst</i>	Istituto Italiano di Tecnologia, Italy
<b>Moroza</b>	Adina	<i>Efficient and stable electrocatalytic hydrogen evolution on bioinspired bimetallic sulfide-based electrodes</i>	Univ. Grenoble Alpes-CNRS UMR 5249-CEA, France
<b>Smiljanić</b>	Milutin	<i>Hydrogen evolution reaction on model trimetallic Rh@Pd/Au(poly) catalyst</i>	National Institute of Chemistry, Slovenia

### Topic 03 - Catalysts for proton- or anion-exchange membrane electrolyzers

<b>Backhouse</b>	Rachel	<i>Challenges for Ultra-Low Platinum Group Metal Catalysts in PEM Water Electrolyzers</i>	ITM Power, United Kingdom
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<b>Holade</b>	Yaovi	<i>Dual electrosynthesis of high purity hydrogen and organic molecules in a biomass-fuelled anion-exchange membrane electrolyzer</i>	Institut Européen des Membranes de Montpellier, France
<b>Jiménez-Morales</b>	Ignacio	<i>Activity-stability relation for iridium oxide nanoparticles deposited on doped tin oxide nanofibres as oxygen evolution catalysts for PEM water electrolysis</i>	ICGM-AIME, France
<b>Marina</b>	Riccardo	<i>Variation of intermetallic distance and OER activity in alkaline media of NiO rocksalt structure with Co inclusions</i>	Industrie De Nora, Italy
<b>Spanu</b>	Francesco	<i>Development of bipolar membrane electrode assemblies for fuel cell and electrolysis</i>	ICGM-AIME, France
<b>Tuleushova</b>	Nazym	<i>Free-standing nanostructured electrocatalysts for selective glycerol oxidation and water reduction as a pathway to dual carbon chemicals and H<sub>2</sub> fuel in low electricity consumption electrolyser</i>	Institut Européen des Membranes de Montpellier, France

### Topic 05 and 06 - Modelling of catalytic sites and reaction pathways & Advanced characterisation techniques

<b>Choi</b>	Chang Hyuck	<i>Quantification of active sites in metal-nitrogen-carbon under electrochemical operating conditions</i>	GIST, Republic of Korea
<b>Cornut</b>	Renaud	<i>Mapping the intrinsic electrocatalytic activity of ORR catalysts with Scanning electrochemical microscopy</i>	CEA/NIMBE/LICSEN, France
<b>Ghedjatti</b>	Ahmed	<i>Electron Microscopy and Small Angle Neutron Scattering studies of bio-inspired catalytic layers for Proton-Exchange Membrane Fuel Cells</i>	CEA/DRF/BIG/LCBM, France
<b>Han</b>	Byungchan	<i>Design of Cost effective Electrocatalysts for Oxygen and Hydrogen Conversion Using First-principles based Machine Learning Computing</i>	Yonsei University, Republic of Korea
<b>Inaba</b>	Masanori	<i>Benchmarking high surface area catalysts in a gas diffusion electrode: measurement of oxygen reduction activities under realistic fuel cell conditions</i>	Toyota Central R&D Labs., Inc., Japan
<b>Kluge</b>	Regina	<i>Identification of Active Electrocatalytic Sites Using Electrochemical Scanning Tunneling Microscopy</i>	Technical University of Munich, Germany
<b>Luo</b>	Fang	<i>Quantifying the Density and Utilization of Active Sites for PGM-Free Bimetallic Metal-Nitrogen-Carbon (BMNC) Oxygen Electroreduction Catalysts</i>	Technical University Berlin, Germany



<b>Mechler</b>	Anna K.	<i>Minute Amounts of Platinum Mitigate Radical Formation in Pt/Fe-N-C Hybrid Catalysts</i>	Max Planck Institute for Chemical Energyconversion, Germany
<b>Ni</b>	Lingmei	<i>Operando <sup>57</sup>Fe Mößbauer Spectroscopy Study on a Fe-N-C Catalyst</i>	TU Darmstadt, Germany

### Topic 07 - Mass-transport issues for non-PGM and ultra-low PGM loadings

<b>Mabuchi</b>	Takuya	<i>Molecular Analysis of Ionomer Aggregations During Drying Process of Alcohol/Water Mixtures</i>	Tohoku University, Japan
<b>Talukdar</b>	Krishan	<i>Innovative Way of Drying PEMFC Electrode</i>	German Aerospace Center, DLR, Germany

### Topic 08 - Ageing and durability

<b>Gonçalves</b>	William	<i>Mechanical properties of Nafion membrane at nanoscale: from elasticity to rupture</i>	Tohoku University, Japan
<b>Kakinuma</b>	Katsuyoshi	<i>Design of Low Pt loading Pt/Nb-SnO<sub>2</sub> Cathode Catalyst Layers with High Activity and Durability</i>	University of Yamanashi, Japan
<b>Kaplan</b>	Dima	<i>Effect of Ruthenium Contamination on the Activity of DMFC Cathode Catalyst</i>	Tel Aviv University, Isarel
<b>Kim</b>	Haesol	<i>Instability of platinum electrode in an electrochemical ammonia oxidation reaction</i>	GIST, Republic of Korea
<b>Martinez-Bonastre</b>	Alex	<i>Integration of Novel Stack Components for Performance, Improved Durability and Lower Cost</i>	Johnson Matthey, United Kingdom
<b>Merzdorf</b>	Thomas	<i>Carbon Corrosion Analysis in PEM Fuel Cells using a Non-Dispersive-Infrared System (ND-IR)</i>	Technical University Berlin, Germany
<b>Rojas</b>	Sergio	<i>Durability studies of Fe/N/C catalysts in acid and alkaline electrolytes</i>	ICP-CSIC, Japan

#### 4. CONFERENCE PUBLICATIONS

A Topical Issue of the journal Springer Nature Applied Sciences entitled Material and Engineering Advances Towards Electrolyzers and Fuel Cells with Earth-abundant Elements is open to submissions from the conference participants, for publication early 2020.

#### 5. CONCLUSION

The work on the conference *Challenges for zero platinum for oxygen reduction and hydrogen oxidation* launched in July 2018 culminated in a very visible and well-attended international conference in September 2019 that was attended by all the key researchers (national laboratories, universities, research institutes, industry) in the field. It provided the opportunity not only for CRESCENDO and CREATE, but also for other FCH JU/H2020 supported projects (e.g. PEGASUS, INSPIRE), to present their results in this international context. The conference was at the highest level of scientific and technical discussion and, just like its predecessor in 2015, sets the reference for future conferences in this field.