SCIENCE OF HYDROGEN & ENERGY AWARD 2016

Prof. Torben R. JENSEN

Torben received his PhD degree (1999) in materials chemistry at University of Southern Denmark, Odense, and did postdoctoral research at Risø National Laboratory and DESY, Hasylab, Hamburg. He became an Assistant Professor (2000) and a Research Associate Professor (2002) at the Interdisciplinary Nanoscience Center (iNANO) and Department of Chemistry, Aarhus University. He was awarded a *Steno* research stipend (2002) by the Danish Research Council, a *Carlsberg* research stipend (2005) from the Carlsberg Foundation and a Doctor of Science degree (D.Sc. in 2014) from the Faculty of Science and Technology at Aarhus University. His research interests are focused on synthesis, structural, physical and chemical properties of new inorganic materials and utilisation of synchrotron X-ray radiation for materials characterization. He has published more than 200 research papers.

Torben R. JENSEN initiated his research career within inorganic materials science, and then moved to biophysics and back to materials science. In the past decade, Torben's research focus has been on synthesis and characterisation of new 'energy materials' for hydrogen storage, batteries and now also conversion of carbon dioxide to useful fuels. Development of new synthesis methods has been the focus during all the years along with utilisation of intense X-ray beams generated by synchrotrons for advanced materials characterisation. Jensen and his group have developed knowhow, new sample environments and gas-control for in-situ powder diffraction investigations of solid-gas reactions. This is now implemented at several synchrotron facilities and has led to a variety of collaborations world-wide. A multitude of new advanced synthesis techniques have also been developed, e.g. new approaches for mechanochemistry, in particular investigation of the reaction mechanisms. Solvent-based methods have been used for preparation of new precursors and several synthesis techniques have been combined to develop novel materials.

The first nano-porous metal hydrides, γ–$M(BH_4)_2$, M = Mg or Mn, with a 3D network of interpenetrated ~9 Å channels, which reversibly adsorb smaller molecules like of H_2, N_2, or CO_2 were prepared by solvent-based methods by Jensen and his group. A wide range of other metal borohydrides were also synthesised and investigated and anion substitution in metal borohydrides was discovered at Aarhus University and first presented in 2006. Another new compound, $LiCe(BH_4)_3Cl$, with a unique structure is the first member of a new class of fast ion conductors. New combined synthesis protocols provide extensive series of high hydrogen density compounds, such as $Y(BH_4)_3{\cdot}nNH_3$, n = 1, 2, 4-7, of general interest, also within coordination chemistry. Detailed structural investigations of metal borohydrides and their ammonia and anion-substituted derivatives reveal that dynamic (entropy) effects may lead to either a contraction or an expansion of the solid state. Jensen also proposed that dynamic or entropy effects are responsible for fast cationic conductivity and ion substitution in the solid state. Reactive hydride composites have also been investigated along with nanoconfinement. New methods to infiltrate several hydrides in nanoporous scaffolds, which may also be functionalised by catalytic nanoparticles are developed.

The research has developed fundamental scientific insights into material structure-property relationships towards rational design of novel, useful, and functional 'energy materials'. During the past few years the Jensen research group has been among the most productive for synthesis of new materials. The group has published 130 peer-reviewed publications since 2010 in a strong international research network with >20 research groups.

We award Prof. Torben R. JENSEN for his outstanding work in the science of hydrides, the discovery of multitudes of new compounds and studies of structure-property relationships with the Science of Hydrogen & Energy prize 2016.