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SEMINAR PRESENTATION

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HYDROGEN STORAGE: HYBRID MATERIALS, PROPERTIES & SYSTEMS

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Magnesium based hybrids have potential applications for hydrogen storage in the solid state. Although magnesium can store a high amount of hydrogen (7.6 wt.%), high temperatures (~300 °C) and pressures (0.3–1 MPa) are required for the same. Additionally, the kinetics of absorption of hydrogen in bulk magnesium is slow. In the current work, Mg-$LaNi_5$-soot hybrids are synthesized by the accumulative roll bonding (ARB) process (30 roll passes, 50% reduction per pass). It is observed that the hybrid absorbs 5 wt.% hydrogen at 250 °C at a pressure of ~0.33 MPa (4.5 wt.% hydrogen at a plateau pressure of less than 0.08 MPa). After 30 ARB passes, the kinetics of absorption of the hybrid was 4.0 wt.% hydrogen in 30 s at 2 MPa, which is 3500% faster than the Mg (ARB) sample and 500% faster than Mg-$LaNi_5$ hybrid. This combination of operating parameters and enhanced hydrogen storage properties (high capacity at lower temperatures and pressures combined with rapid kinetics) offer exciting prospects towards applications, given that bulk samples can be synthesized in large quantities using the process developed. After 25 ARB passes there are more than 10^5 layers in the hybrid and the layer thickness becomes less than ~24 nm. Hence, intimate mixing of the components of the hybrid, along with a fine microstructure and increased defect density in the hybrid, seems to play an important role in the enhancement of the hydrogen absorption properties.

We have dedicated our efforts towards the designing and fabrication of high temperature (~400 °C) metal hydride based hydrogen storage and retrieval system (hydrogen storage canister) with novel core heating attachment for efficient heat transfer and faster kinetics as compared to external heating. The material used for testing hydrogen storage canister is Mg-$LaNi_5$-soot (30 ARB passes). The idea is to design and fabricate a working prototype which can store hydrogen (working as a hydrogen battery) and provide hydrogen (on heating) when required. The performance of the metal hydride based hydrogen storage reactor depends on many parameters. The most crucial role is played by the design of the hydrogen storage and retrieval system.

For the first time we are investigating accumulatively roll bonded Al-$LaNi_{4.6}Al_{0.4}$ hybrid for mechanical energy damping applications

Refereed Journal Publications

1. "*Nickel nanoparticle-doped and steam modified multiscale structure of carbon micro-nanofibres for hydrogen storage: Effect of metal, surface texture and operating conditions*". Ashish Yadav, **Mohammad Faisal**, Anandh Subramaniam, Nishith Verma, ***International Journal of Hydrogen Energy***, 30 November 2016, pp 1-14.
2. "*Hydrogen Storage in Mg-Mg_2Ni-carbon hybrids*". Anshul Gupta, Suboohi Shervani, **Mohammad Faisal**, Kantesh Balani, Anandh Subramaniam, ***Journal of Alloys and Compounds***, Volume 645, 5 October 2015, S397-S399.
3. "*Enhanced hydrogen storage in accumulatively roll bonded Mg-based hybrids*". **Mohammad Faisal**, Anshul Gupta, Suboohi Shervani, Kantesh Balani, Anandh Subramaniam, ***International Journal of Hydrogen Energy***, volume 40, Issue 35, 21 September 2015, 11498-11505.

Patent

"*Hydrogen Storage in Magnesium based Hybrids Using Accumulative Roll Bonding*". **Mohammad Faisal** (inverter), Anshul Gupta, Suboohi Shervani, Kantesh Balani, Anandh Subramaniam, Indian patent no. 119/DEL/2014. Accepted.

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Mohammad Faisal was born in 1985, Kanpur, Uttar Pradesh, India. Faisal graduated with a Bachelor of Technology (B.Tech) in Materials Science and Metallurgical Engineering in 2008 from UIET CSJM University Kanpur, India. Faisal attended Jamia Millia Islamia, Central University, New Delhi, India and graduated with Master of Technology in Nanotechnology in 2011 and secure gold medal. During this period, Faisal worked on *"**Growth of CNT's & Growth of GRAPHENE using Atmospheric CVD & PECVD, Their Applications & Characterization, Designing and Fabrication of PTCVD & Growth of Graphene and CNT using PTCVD**"* for his thesis as research intern at Solid State Physics Laboratory, Defense Research and Development Organization, New Delhi, India. In 2011 he joined Indian Institute of Technology Kanpur, India, as a doctorate scholar in the Department of Materials Science and Engineering. He is working on ***"HYDROGEN STORAGE: HYBRID MATERIALS, PROPERTIES & SYSTEMS".*** Faisal is the pioneering student for the study of hydrogen storage at IIT Kanpur.