Color Changing Hydrogen Sensors

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THE MISSION

During the Space Shuttle Program, one of the most hazardous operations that occurred was the loading of liquid hydrogen (LH2) during fuelling operations of the spacecraft. Due to hydrogen’s low explosive limit, any amount leaked could lead to a catastrophic event. Hydrogen’s chemical properties make it ideal as a rocket fuel; however, the fuel is deemed unsafe for most commercial use because of the inability to easily detect the gas leaking. The increased use of hydrogen over traditional fossil fuels would reduce greenhouse gases and America’s dependency on foreign oil. Therefore a technology that would improve safety at NASA and in the commercial sector while creating a new economic sector would have a huge impact to NASA’s mission.

THE TECHNOLOGY

Color change of the irreversible sensor over time.

The principal advantage of these tapes over other hydrogen sensing technologies is that they do not require power for operation, which is desirable since hydrogen is flammable and electronics represents a potential ignition source. One of two different pigments can be incorporated into the tapes, one that changes color only once (i.e., irreversible) upon exposure to a threshold dose of hydrogen and one that changes colors multiple times (i.e., reversible) upon cycling between hydrogen and oxygen containing environments. This technology is significant, because it provides a breadth of possible applications for safe operations when using gaseous or liquid hydrogen. The technology in supporting NASA’s highest priority in safety could also have a significant benefit in helping protect the surrounding environment, like the Kennedy Space Center’s National Wildlife Refuge or surrounding areas of Stennis Space Center in helping decrease chances of large scale fires. As (1) the hydrogen economy becomes more prevalent, (2) the cost of gasoline rises, and (3) carbon dioxide emissions are further regulated, technologies like the Chemochromic Detector would be regularly used to improve public safety, awareness, and confidence.

DEPLOYMENT AND OPERATIONS

Deployment of tape for cross country lines during STS-130.

Testing on hydrogen pressurization lines during tanker loading.

Products include tape, paint, injection and blow molded parts, fibers, and textiles.

AWARDS AND RECOGNITION

R&D Magazine’s 2014 R&D 100 Award
NASA 2014 Spinoff Magazine Feature
2009 NASA Environmental and Energy Award
4 US Patents Issued, 2 Pending

Chemochromic Hydrogen Leak Detectors

TEAMWORK LEADS TO SUCCESS

The team that invented and commercialized the Chemochromic Detector consists of 12 people: Dr. Luke Roberson, a KSC chemical research scientist and principal investigator, Dr. Martha Williams, a KSC NASA chemist and lab lead, and Dr. Janine Captain, a KSC NASA environmental chemist, all located within the Materials Science Division of the Engineering Directorate at KSC. Trent Smith, now with the KSC Space Station Directorate, and Dr. Loretta Tanc, now with NASA HQ, supported article manufacture of tapes and fabrics. Dr. Ali T-Raisi, Dr. Nahid Mohajerji, Dr. Gary Brokerman and Dr. Nazim Muradov, all employed by the Florida Solar Energy Center at UCF, invented, synthesized, and patented the reversible and irreversible pigments. This broad team with unique expertise worked to come up with a solution that would provide a safe, effective, and economical way to locate a hydrogen leak. New Walsh, CEO of DWAL Industries, was a collaborator through a NASA SAA. Shelley Ford and Jim Nichols assisted in the patenting and technology transfer. Dr. Nahid Mohajerji, founder and CEO of HySense Technology, LLC, is the licensee of the technology portfolio. The Chemochromic Detectors project is formally a Joint Ownership Agreement (JOA) between NASA’s Kennedy Space Center and the University of Central Florida’s Florida Solar Energy Center. Research was initially funded through a NASA grant to Florida universities for FSEC to invent chemochromatic pigments that would detect leaking hazardous gases. Co-development of the technology was performed at FSEC to improve and advance the pigment’s response rate and capabilities, while NASA incorporated the pigments into articles manufacturable for launch and commercial applications. NASA deployed these test articles for Shuttle and ground operations and provided feedback to the professors to enhance their pigments. Our collaboration with NASA Engineering operations provided successful technology infusion into NASA operations at the launch pad, at WSTF engine operations, and in the MSCI safety courses. After a successful product was created in the lab and deployed on the field, commercial scale manufacturing was approached for large scale manufacturing and license opportunities. Through teamwork with the NASA-KSC Patent Office, Technology Transfer Officers at UCF and NASA, the team filed 6 patents, a NASA Space Act Agreement, and a joint license agreement to transfer the technology into industry through HySense Technology. External customers were also a big influence on the development of this invention. Companies such as BMW, Chevron, and Air Products provided helpful feedback when developing this technology portfolio for a wide range of commercial applications. This project was an ideal case for how leadership and teamwork came together to take a high-impact environmental technology from concept to commercialization.

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POINTS OF CONTACT

For questions regarding research and technology development, please contact Dr. Luke Roberson (Luke.B.Roberson@nasa.gov).

For licensing and purchasing of products, please contact Dr. Nahid Mohajerji (Nahid@hysensetechnology.com).