Hydrogen Leak Detection Tape

NASA Kennedy Space Center (NASA KSC) scientists collaborated with University of Central Florida (UCF) researchers at the Florida Solar Energy Center (FSEC) to invent hydrogen leak sensors

The initial development was prompted by NASA's need for a safe and consistent way to test hydrogen on and around the launch pad environments. During the Space Shuttle Program, NASA utilized huge quantities of liquid hydrogen as a fuel source, as hydrogen is the most effective propellant there is. However, it is also highly volatile and challenging to keep it in a liquid state (requiring temperatures below -423 F), it is also highly flammable, invisible and odorless. Given the difficulties associated with managing hydrogen, it was exceedingly important to be able to track and deal with leaks in the miles of pipeline used for fueling the shuttle. The existing instruments used for finding leaks were not exact, making leak detection and management challenging, time consuming and expensive. Hydrogen gas leaks pose significant safety and maintenance problems for organizations that use hydrogen. Facility managers reported that finding the exact location of hydrogen gas leaks in an industrial setting is such a difficult problem, that it can cost millions of dollars in resources and labor. It was obvious that a better system was needed.

Researchers at the Kennedy Space Center began working on a better solution. Not long after the Florida Solar Energy Center (FSEC) at the University of Central Florida (UCF), received a grant from NASA to lead a hydrogen research program. Robert Youngquist, head of Kennedy's applied physics lab, reached out to one of the grant's principal investigators, Dr. Ali Raissi, and a collaboration was struck between the two organizations. NASA Kennedy Space Center (NASA KSC) scientists collaborated with University of Central Florida (UCF) researchers at the Florida Solar Energy Center (FSEC) to invent hydrogen leak sensors, utilizing a combination of

color-changing chemical reaction. The “support” color is still important, because it has to be different enough to contrast with the color of the reaction, this is critical for visibility. The team had to develop an iteration of the pigment that had the right color contrast, a very fast reaction, and could be applied to a silicone-based tape, which provided the necessary encapsulation properties. After about two years an appropriate pigment formulation was achieved; the visual sensor quickly turns from an amber to a black color, when exposed to hydrogen gas.

The implementation of such devices is often difficult because of environmental interference and gas permeability of the host materials. Researchers from UCF and NASA KSC solved the implementation issues by combining a pigment in a novel silicon matrix (tape) that is environmentally resistant, while being hydrogen permeable. The tape, when exposed to H2 gas, undergoes a color change transformation from beige to a uniform black color.

The sensor is extremely versatile and can be incorporated into a wide variety of commercial products through molding into rigid or flexible shapes such as tape or fiber, which can be used in protective safety garments. This sensor was proven to be very effective for pinpointing the exact location of leaks in hydrogen gas lines and fittings at launch pads and industrial facilities. When used in tape form and wrapped around pipes, fittings or flanges, they can detect the presence of hydrogen gas in concentrations as low as 0.1% to pinpoint the location of a leak.

The inventors won the prestigious R&D 100 award in November 2014 and the 2015 TechConnect Innovation award for the hydrogen leak sensors. The recognition from the R&D 100 Awards validates the great things that can come from partnerships, collaboration, and ingenuity.
The NASA KSC Technology Transfer Office worked with UCF to develop a marketing and commercialization plan for the technologies. NASA KSC executed both a patent license agreement (with a sub-license clause) and a Space Act Agreement with UCF to accomplish the technology transfer. UCF combined their patents with NASA KSC’s and marketed them as one intellectual property portfolio. NASA KSC assisted with marketing and

lead generation, as well as technical support. One of the UCF researchers and co-inventor of the technology founded a startup company called HySense Technology LLC with the assistance of UCF’s business support services. HySense licensed the technologies from UCF and has fully developed and marketed its product, known as Intellipigment™. Hysense had more than dozen commercial customers. The company won a $100,000 first-place award at an innovation competition at the Innovation Concourse of the Southeast: Safety & Manufacturing event in Orlando, Florida.