NREL
NATIONAL RENEWABLE ENERGY LABORATORY

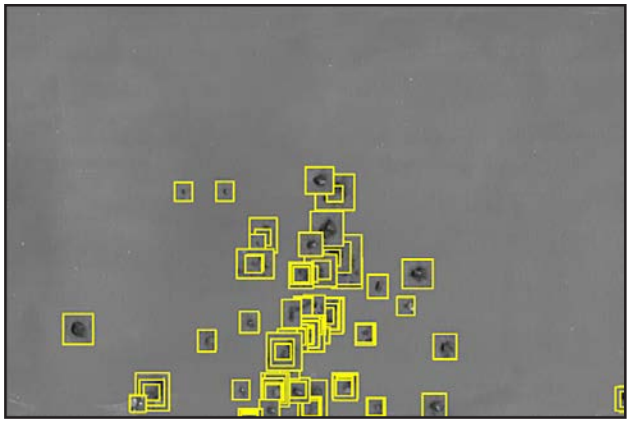
NREL Develops High-Speed Scanner to Monitor Fuel Cell Material Defects

Highlights in Research & Development

The fuel cell scanner could provide effective in-line quality control in a high-volume manufacturing facility.

NREL scientists have developed and built a high-throughput, high-resolution, in-line fuel cell scanner to monitor quality and detect critical defects in polymer electrolyte membrane fuel cell (PEMFC) materials.

The fuel cell scanner uses a visible light diffuse reflectance imaging technique to generate high-resolution images of PEMFC materials as they are transported along a roll-to-roll production line. The system consists of a monochromatic line camera with an optical lens that has a 12-inch-wide field of view. The camera's silicon detector is built of one row of 12,288 pixels that are sensitive in the visible/near infrared spectrum of light. These camera components can be installed on a full-scale, high-volume fuel cell production line to image and analyze hundreds or thousands of feet of material each day.



Automatic detection of debris in an 8-inch by 11-inch fuel cell catalyst-coated electrode. The insets with debris defects are magnified 10 times.
Image by Peter Rupnowski, NREL

NREL has used the fuel cell scanner to generate good-quality, high-resolution images of baseline, defect-free samples as well as samples with intentionally introduced debris, slit, scuff, score, and pinhole defects. To make the reflectance-scanning technique useful for industrial-scale processes, NREL developed an automatic computer vision algorithm that makes it possible to detect the presence and location of defects in real time. The research team applied the algorithm to the scanned images of debris-containing specimens and demonstrated that the algorithm can effectively detect debris particles without generating any false positives.

Although the fuel cell scanner does not produce images with the same level of detail as an optical microscope, it can map an entire, continuous-length material in one scan. Therefore, the system can be applied as an in-line quality control or process monitoring tool on a real high-volume production line.

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References: Rupnowski, Peter, Michael Ulsh, and Bhushan Sopori. *"High Throughput and High Resolution In-Line Monitoring of PEMFC Materials by Means of Visible Light Diffuse Reflectance Imaging and Computer Vision."* Proceedings of the ASME 2015 Power and Energy Conversion Conference, San Diego, CA, June 28-July 2, 2015.

Key Research Results

Achievement

NREL built a high-throughput, high-resolution, in-line fuel cell scanner that uses a visible light diffuse reflectance imaging technique to monitor quality and critical defects in PEMFC materials. The laboratory's researchers also developed a computer vision algorithm to automatically detect the presence and location of defects in real time.

Key Result

NREL generated high-resolution images of baseline and defect-containing samples and demonstrated that the scanner can successfully image debris, slit, scuff, score, and pinhole defects. The team applied the computer vision algorithm to the debris-containing samples and showed that the algorithm does not generate false positives.

Potential Impact

NREL's fuel cell scanner has the potential to be an effective process monitoring and in-line quality control tool that can help reduce the cost of manufacturing PEMFCs and potentially many other technologies.

The scanner can be installed on a full-scale, high-volume fuel cell production line to take images of and analyze hundreds or thousands of feet of material each day.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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NREL/FS-5900-64828 | September 2015

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