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Spectroscopy Innovations 13

Spectroscopy Innovations is a newsletter published by Renishaw plc. It brings you the latest information about new Raman products, new applications, and forthcoming events.

In this issue

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I would like to hear about exciting work you are doing with your Renishaw Raman system for publication in future newsletters. Please contact me with details!

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Helping the environment

This issue of Spectroscopy Innovations highlights some of the many ways in which Renishaw's customers are using Raman technology for a 'greener' tomorrow.

Renishaw is an environmentally conscious and responsible company, and its corporate environmental policy is an integral part of its business strategy.

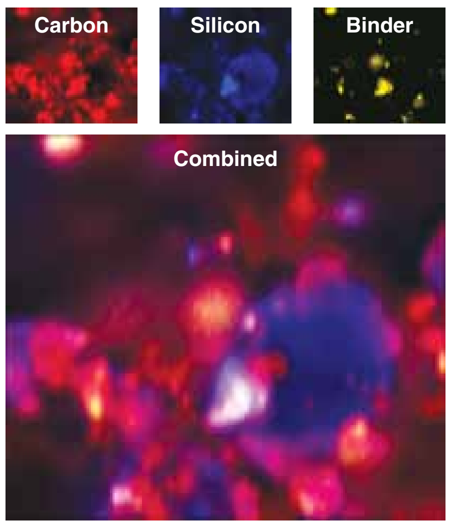
It is Renishaw's policy to strive to ensure that all aspects of the business have the least harmful effect on the environment.

Greener transport

Motor manufacturers regularly announce the release of novel battery powered electric vehicles. Compared to the lithium-ion batteries in cell phones or notebook PCs, the batteries used in cars require very high output power, short charging time, long life, excellent safety, light weight, and low production cost. This translates into a need for higher-performing battery components made from chemically and structurally robust materials.

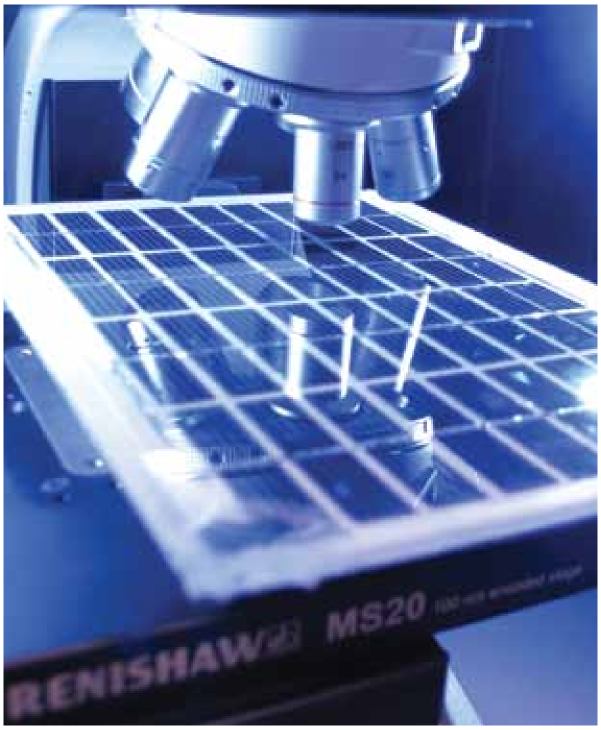
Silicon is attracting much interest as an alternative anode material to the graphitic carbon used in conventional lithium-ion batteries, as it offers up to 10 times the charge and discharge efficiency. However, silicon anodes are not as durable as their carbon counterparts. Research suggests that durability can be improved if the silicon is coated with a thin layer of carbon, and, since both these elements yield characteristic Raman spectra, Renishaw's StreamLine Plus™ imaging technique is the ideal tool to help in the research.

The Raman images provide valuable insights into the distribution, homogeneity, and structure of the Si-C composite anode particles, which, in turn, can be related to electrical performance. These images can be acquired in a matter of minutes, and without exposing the samples to air, making Raman a strong candidate for QC *in situ* testing when these new materials go into production.



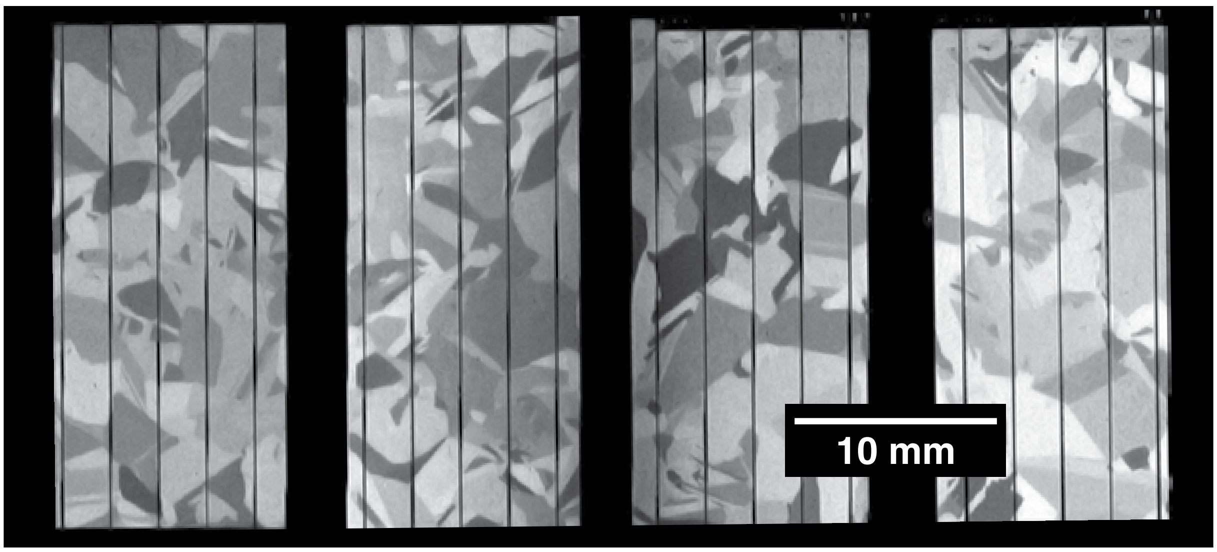
inVia StreamLine Raman images of carbon (red), silicon (blue) and binder (yellow) show the distribution of the individual components. Blue areas in the combined image show where silicon is predominant, indicating an absent or thinner carbon coating compared to other areas.

Efficiently using the sun's energy



Efficient use of solar energy to generate commercial and industrial power has long been a desired goal. Environmental concerns, government targets, and the increasing cost of traditional fuels has generated more research and potential product opportunities in recent years. Whilst a multitude of novel materials (such as $CuIn_{1-x}Ga_xSe_2$ and CdTe) are being researched and improved, silicon based materials still lead the industry because of their high efficiency and abundance of raw material.

The high initial energy demands and costs of manufacturing single crystal silicon solar cells reduces the commercial appeal of this material and has resulted in the development of amorphous and polycrystalline variants. Although these aren't as efficient as single crystals, they require significantly less energy to fabricate and still have excellent efficiency when compared to other materials. The compromise between manufacturing effort and cell efficiency is critically important to ensure modules are commercially viable and practical to produce. Optimising cell efficiency, and understanding the parameters that affect efficiency during fabrication, are critical for manufacturers.



Polycrystalline silicon cells consist of a series of multiple domains with different crystal orientations. Where a larger number of small domains is present, the efficiency of these cells is reduced, due to the large number of boundaries between the domains. The Raman image above shows how StreamLine imaging can be used to identify the different domains: we then use this information to quantify the boundary distance. The ability to sample data over very large areas, seamlessly, in minutes, makes StreamLine imaging the ideal method for rapidly surveying these cell modules.

Where high spatial resolution images are required (for example, to determine inter-domain variations and the affect of domain boundaries on device stresses), StreamLine's high resolution imaging is the method of choice. This method enables users to acquire information-rich images on the sub-micrometre scale. Renishaw also provides systems for on-line solar panel inspection for quality assurance applications during manufacture.

Renishaw's Raman systems therefore provide the full suite of Raman capabilities that researchers and manufacturers need. This enables a complete understanding of the sample characteristics and morphology on the macro- and micro-scale, whether in the laboratory or on the production line.

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Harnessing solar energy

PRAMAC Swiss SA, part of the PRAMAC multinational group, began producing thin film solar panels in July 2009. Their plant, based in Riazzino, is the largest solar panel production facility in Switzerland. It produces Micromorph® panels that use multi-layer thin film technology: active hydrogenated silicon layers (Si:H) and transparent conductive oxide (TCO) contact layers are deposited on a glass substrate by chemical vapour deposition. This layered technology increases absorption in the near-infrared and significantly increases efficiency.

PRAMAC Swiss SA prides itself on quality and has an extensive QC department, headed by Dr. Nadia Galimberti. Raman spectroscopy was one of the first analytical techniques chosen by PRAMAC Swiss SA for use in both its production plant and its quality control (QC) laboratory, because of its well-accepted role in characterising micro-crystalline silicon. The QC laboratory also employs: ellipsometry, for layer thickness and optical constant measurements; transmittance spectrophotometry, for the determination of the TCO layer roughness or 'haze'; panel quantum efficiency measurers; sun simulators; weathering rooms for damp-heat tests; mechanical shear testers; and a light soaking bench for cell ageing.

Raman analyses in the QC laboratory are performed using an inVia Raman microscope, with 20 panels being withdrawn from production for test every 15 days, just after first deposition of the Si- Si thin layer. Each panel is then cut into 13 square samples, and the crystalline fraction of each sample is measured at three different points. This process has been semi-automated with Renishaw's WiRE software custom analysis package (CAP), allowing a range of standardised procedures to be developed, each one efficiently automating part of the QC operation. CAP's user-friendly interface has also enabled efficient multi-operator use.

"The use of the Renishaw Raman microscope in PRAMAC Swiss SA has given a fundamental contribution in terms of performance growth, both at initial production steps and on the final product."

Dr. Nadia Galimberti, PRAMAC Swiss SA.

Photographs courtesy of PRAMAC Swiss SA.
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Consuming less power

The inVia Raman microscope has long been used as a tool for investigating new technology for generating power more efficiently than traditional methods (such as coal-fired power stations). Today, more than ever, environmentally friendly energy production methods, such as solar power and fuel cells are needed, and inVia is playing a key role with research and quality control in these areas.

inVia's renowned high performance, versatility, and flexibility make it ideally suited for investigating and testing these new and improved power production methods, but did you know that a huge amount of effort is also put into minimising power consumption and environmental impact of the inVia itself?

This has resulted in an instrument which—even when configured with popular and extensive accessories, multiple laser excitation sources, and StreamLine imaging—consumes less than 150 W of power (less than a typical desktop computer).

Some examples of how this efficiency is achieved:

- Where appropriate, LED lighting is used (0.7 W of power, rather than 50 W for halogen lighting)
- inVia's Class 1 enclosure uses intelligent power switching (only consumes power in the brief interval when the door is released); this saves 2.5 W
- High quality power factor corrected power supplies with up to 90% energy efficiency
- Each of Renishaw's high power near-infrared diode lasers uses only 8 W of power
- inVia's highly automated and accurate motor encoding technology enables motors to be dormant for most of the time. This results in a large routine power saving, without compromising inVia's renowned stability
- Renishaw's patented high speed encoded stage (HSES) uses significantly less power than a conventional motorised microscope stage

The inVia: helping the environment in every way.

Exhibitions and conferences

Every year Renishaw attends a range of 'premier' events worldwide. Please come and talk to your local Renishaw representative at one of the following events.

Europe	**Art'11: 10th International Conference**	
	Florence, Italy	13 to 15 Apr 2011
	Hydrogen Storage Materials: Faraday Discussion	
	Didcot, UK	18 to 20 Apr 2011
	ANALITIKA - TESTex	
	Moscow, Russia	26 to 29 Apr 2011
Asia	**Interphex Japan 2011**	
	Tokyo, Japan	29 Jun to 1 Jul 2011
	JAIMA 2011	
	Chiba, Japan	7 to 9 Sep 2011
Americas	**MRS SPRING 2011**	
	San Francisco, California	26 to 28 Apr 2011
	21st I-APS Conference	
	Mendoza, Argentina	17 to 20 May 2011
	Expo Physics	
	Foz do Iguaçu, Brazil	5 to 9 Jun 2011

Why not attend one of Renishaw's Raman seminars?

Following the popularity and success of previous events held in Asia, Europe, and Scandinavia, Renishaw is planning a series of events in various locations around the world. Please check our website for updates or email raman@renishaw.com and ask to be put on our mailing list.

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