Metrology for **energy harvesting**

European Metrology Research Programme

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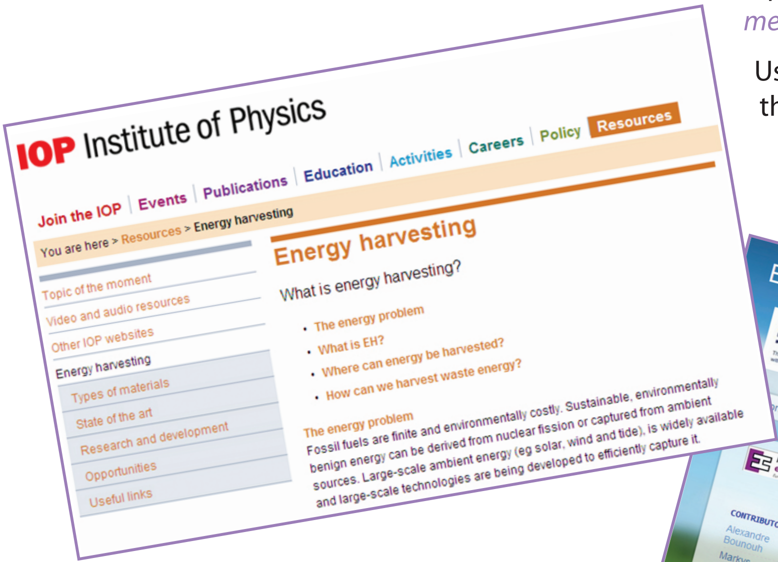
Project news

Web collaboration with IOP

The Metrology for Energy Harvesting project has been working with the Institute of Physics on a new section for its website, dedicated to microscale energy harvesting. This provides an overview of the technology, R&D, and challenges in the sector. The pages went live at the end of March, and can be viewed at *www.iop.org/resources/energy*



Project blog launched

The Metrology for Energy Harvesting project has a new dedicated blog to discuss issues, announce news, and facilitate industry feedback. We welcome external views, comments and contributions. Visit the blog at *http://emrp-metrology-for-energy-harvesting.blogspot.com*

If you'd like to become a contributor, or propose a topic then contact Melvin Vopson, *melvin.vopson@npl.co.uk*

Use your Google, Yahoo or Twitter account to 'follow' the blog so you never miss an update.

Spreading the word

The IOP Blog has published an opinion piece from Prof Markys Cain about the importance of metrology in developing the energy harvesting market. The article, **Metrology: moving energy harvesting forward** (published 13 April), can be read at *www.iopblog.org*

We welcome suggestions for articles and features. Please send your ideas to Robin Wilkinson robin@proofcommunication.com

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Project news (cont.)

NPL's multifunctional materials team was strongly represented at Piezo 2011 (28 Feb – 2 Mar). The conference attracted over 100 attendees, evenly split between academia and industry. Participants from UK, Germany, Italy, Spain, Denmark, Switzerland, Korea, USA, Japan, Russia, and Norway presented on a variety of topics, including leadfree piezo, characterisation, novel processing methods, and energy harvesting. NPL presented a paper on the measurement and quantification of energy losses in piezoelectric energy harvesters. This provided novel insight into important loss mechanisms in energy harvesting cantilevers. This work forms part of the Metrology for Energy Harvesting project.

Dr Alexandre Cuenat and Dr Mark Stewart attended Harvesting 2011 on 7 February in London. They met representatives from academia and industry (including Cardiff University, Holst Centre Berlin, Rolls-Royce, Micropelt, and Perpetuum), who expressed interest in the project's research on thermoelectrics and development of energy harvesting standards.

Dr Alexandre Cuenat from NPL presented on efficiency measurements of thermoelectric generators on 6 April at Thermoelectric Energy Solutions. The workshop, which attracted automotive industry delegates from the US and Germany, explored emerging technologies and opportunities in the development of next generation thermoelectric and thermionic devices. All industry delegates asked for measurement, noting that the values they are quoted for materials need to be substantiated. Speakers included representatives from Jaguar Land Rover, Ilika Technologies Ltd, and the universities of Cardiff, Glasgow and Royal Holloway.

Dr Mauro Zucca (INRIM) was invited to present the Metrology for Energy Harvesting project at Metrologia e qualità 2011 (Metrology and quality 2011), an Italian conference in Turin (Italy), 13-14 April. The conference focus was measurements for manufacturing and services, from large industry to SMEs. The aim was to facilitate meetings and understanding between academic metrological institutions and industry. The conference attracted over 4,000 delegates – predominantly from industry – providing a great opportunity to raise the profile of the project with representatives from the automotive, aerospace, aeronautics, railway, naval and nautical sectors, and specialist engineering companies. The affiliated exhibition Affidabilità e tecnologie (Reliability and technology) was focused on innovation and reliability issues.

Dr Mauro Zucca (INRIM) is also presenting at the Intermag 2011 in Taipei, Taiwan on 29 April. Intermag is one of the major world events regarding magnetism attracting 1,500 researchers from academia and industry. The conference explores all aspects of magnetism, including power applications such as energy harvesting. Dr Zucca's talk will discuss the modelling of amorphous ribbons in energy harvesting applications.

The Metrology for Energy Harvesting project has been contacted by the organisers of IMEKO MI2011, the joint IMEKO TC11, TC19, TC20 International Symposia on Metrological Infrastructure, Environmental and Energy Measurements (15-17 June, Croatia). Energy measurement and standards is a key topic, so abstracts have been solicited from project partners on energy metrology, standards, calibration strategies and traceability schemes.

Upcoming events

MRS Spring meeting

25-29 April
San Francisco, USA

Intermag 2011

25-29 April
Taipei, Taiwan

Intelligent Energy Harvesting

5 May
London, UK

E-MRS Bilateral Conference on Energy

9-13 May
Nice, France

XIV International Forum on Thermoelectricity

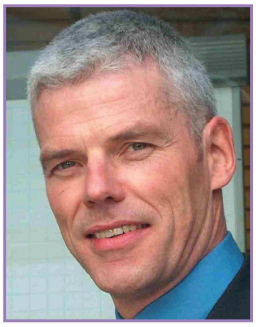
17-20 May
Moscow, Russia

Nanotech 2011

13-16 Jun
Boston, USA

View from industry:

Burkhard Habbe,
VP Business Development,
Micropelt GmbH



Burkhard Habbe is a volunteer member of the ISA100.18 Power Sources Working Group, which aims to define a standard for electrical and physical properties of an interface to connect field instrumentation with any type of compliant harvester.

Micropelt develops and commercialises thin film thermoelectric components based on semiconductor manufacturing processes. It uses planar technologies and silicon wafers as substrates for Peltier cooler and thermogenerator devices.

Its thermogenerators contain hundreds of thermoelectric elements, known as leg pairs or thermocouples. These feature a very high voltage density and produce sufficient energy to drive a wide range of low-power wireless applications including remote sensors, data loggers and small actuators.

The chip-thermogenerators can easily be integrated into all kinds of custom mechanical designs for self-sufficient heat-exposed applications.

Micropelt GmbH started as a collaboration between Infineon Technologies AG and the Fraunhofer Institute for Physical Measurement Techniques in Freiburg (Germany).

How long has Micropelt been interested in energy harvesting (EH)?

It's been a consideration of the business plan from the outset – from when we were set up in 1998.

The technology of thermoelectric devices kicked off as an R&D project. We were looking at developing the technology of TE on wafers and chips.

How did Micropelt move from research into development of thermoelectric EH?

By 2006 we'd developed a good proof of concept, with the required level of performance for cooling and power generation. It was a good time to start considering the market – particularly for wireless applications – as this proof of concept coincided with the availability of ultralow power electronics.

By 2007 we offered EH power on a chip at the simple integration level. The field still needed to establish credibility so we took it a step further by developing demonstrations and evaluation kits for battery-less, ultralow power electronics. This changed the picture completely.

What is the relevance of metrology for EH to Micropelt?

The understanding of EH technology and its possibilities is still at the beginning. We need standards because this facilitates understanding and assessment of the available power, it means that claims and findings can be validated with little effort. This is needed to address the questions that consumers and customers have.

Batteries are known quantities – they have dependable ratings and information in terms of the energy available. We need to have something similar for harvesters to get wide-spread market penetration.

When the capabilities of EH devices are as easy to understand as batteries then the technology will have fully arrived at the end user.

Are you noticing increased customer interest in EH technologies?

Absolutely. There's interest from many industries, but especially from original equipment manufacturers (OEMs) of advanced wireless systems addressing both consumer and process industry applications.

What do you see as the main metrology challenges for EH devices?

We need predictability of performance in the application, but the results you get are strongly dependent on the harvester design, and whether the harvesting target has performance-influencing properties such as convection. It also depends on the source of energy – how regular or constant it is, how much the intensity varies.

Customers want devices to come with an ID tag or specification sheet so that they can get a precise idea of what they can expect. Ideally, we need references that can be related to real applications – ie, if the temperature of the harvesting surface is X and the air temperature is Y, then we can refer to a diagram and calculate the power generated will be Z.

The technology isn't complicated but there are some tasks that industry needs to accomplish before we reach the specification sheet stage. We need to agree how to qualify and quantify different types of harvester so that we can compare different devices.

Metrology is one of the tools that will make EH technology comprehensible, standardised and straightforward for the user.

What will successfully addressing these challenges mean for Micropelt?

It'll be easier to approach potential customers as the technology will gain credibility if results are established by internationally recognised standards. It'll help the entire sector move forward.

Some EH products are already commercially available – what impact has the lack of traceable measurement had on such products?

It's had some impact, but it's difficult to gauge how much.

Customers so far have had to spend time evaluating EH devices under their selected operating conditions. This takes time and budget, but makes sense because there's no better way of assessing to what extent the respective application's requirements will be fulfilled. There's much experimenting due to the lack of experience for different environmental and operating conditions – the pitfalls and limitations need to be established in each case. This means that at present EH is still very application specific and every customer has to build their related experience.

With the development of every new technology it's necessary to explore the field and learn the capabilities and limitations through experiment and measurement. Only once these are known can the technology become more of a commodity.

Where do you feel that European capability ranks in terms of developing innovative EH products?

Europe appears to me the furthest along in commercialisation of standard products and also as the leader in R&D.

However, there seem to be more local players in the US with experimental and partly productive field applications.

Recently Japan has become very interested in EH, and has just set up a new EH consortium (Micropelt is the first, and presently only, non-Japanese member company). We also see that Japanese companies are willing to spend money on assessment and adoption of EH so it is one to watch for the future.

Still, for the time being, Europe has the chance to maintain its leadership in the field. Further success will be largely dependent on support and adoption by instrumentation OEMs and end users, industrial and commercial, as well as consumers.

Another benefit would be the independence from power sockets and batteries – this will make certain applications easier. For example, condition monitoring of bridges, pipelines, or railroad tracks would be much easier with EH sensors, as there would be no need for regular site visits to replace batteries.

We welcome feedback, opinion and suggested articles. Please send your comments to markys.cain@npl.co.uk and robin@proofcommunication.com

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