obducat

IN SIGHT

SOLAR POWER

SPOTLIGHT ON THE WORLD'S
MOST ABUNDANT ENERGY SOURCE

NEWS ON NEMS

A PROMISING BUSINESS
STARRING NIL

No 2/08

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WRAPPING UP AN EXCITING YEAR

With 2009 just weeks away, it's time to sum up a year that has been characterized by several world firsts' commercial breakthroughs for Obducat. The Sindre® HVM order concerning a full-scale mass production system producing 600 HDD substrates per hour and the Sindre® 400 that will be used to produce high-efficiency LEDs. Beyond that several other several other Sindre® 60 systems has been installed during 2008 which are now being used for manufacturing LEDs on a continuous basis.

The financial crisis and the following economic downturn creates uncertainty as to how quickly our customers will expand. On the positive side the prioritized areas LED, HDD and Display are, from recent published market reports, still expected to see growth even during 2009, which reinforces the view that further expansion can be anticipated.

During October–November 2008 we have realized an order take in the range of 13 MSEK which means that we have a 12-month rolling order take level of 100 MSEK.

Additionally key patents have recently been approved concerning our IPS® and STU® processes which further strengthens our uniqueness and competitiveness especially form a mass production solution provider.

Inroads to new geographical markets has also been accomplished recently with a sale of an Eitre® system to the Indian Institute of Technology Kanpur (IITK), one of the top three engineering universities in India.

I would like to take the opportunity to thank everyone who has commented on the launch of Obducat InSight – it seems to have been well received by many, which we naturally are happy to hear of.

For this, the second issue, we have delved into a new and very promising aspect of NIL technology. Solar power, or more specifically photovoltaics, has generated renewed interest as a possible energy source for the future. Until recently, solar power has been considered too expensive and low-efficiency, but new technology in combination with a worldwide quest for cleaner energy may have turned the tide.

Moreover, we take a look at NEMS AB, a Swedish company building its success on a sensor device developed by using Obducat NIL technology. But I'm getting ahead of myself. Read about it yourself in the following pages.

We look with anticipation to 2009 as a new year that is sure to hold many new customers, partnerships and Obducat news to report on.

Patrik Lundström
CEO

A BRIGHT FUTURE FOR SOLAR POWER

The inherent problem with converting sunlight into electricity has historically been poor efficiency. But things are changing for the better. With new technology and new materials being developed, there is also a promising market emerging. Above all, hopes are tied to solar power as a serious alternative to today's short-sighted energy solutions – clean as it is, and infinite in supply.

In theory, its all very simple. Just a small patch – a square with the side 300 miles – of the Sahara covered with solar panels would suffice to provide the world's entire energy need (and that's with today's rather low-efficiency solar cells). But even with the most optimistic of perspectives, this scenario remains a distant dream. If all the forecast growth of this budding market becomes reality, solar energy in 2020 will still represent only about 3 percent of installed electricity generation capacity, and 1.5 percent of output. Nevertheless, the interest in this field has grown exponentially over the last few years.

For all practical purposes, it all boils down to CPW, cost per watt. Since it defines an installation's cost and the point at which the site breaks even, it is also the most important metric in the solar industry. It provides a basis for comparison among photovoltaic technologies and between installations, as well as between solar energy and other sources of electricity.

To improve CPW, manufacturers can either reduce cost – by improving yield, increasing throughput, and pulling all the other levers available to a manufacturing process – or they can increase the wattage available from a given panel area. In turn, increasing output power requires improved conversion efficiency: the panel must capture more incident photons, convert more of them to free carriers, and deliver more of those carriers to the panel's terminals. Each of these steps – capture, conversion, and transport – shaves points from the ultimate efficiency and offers opportunities for performance improvements.

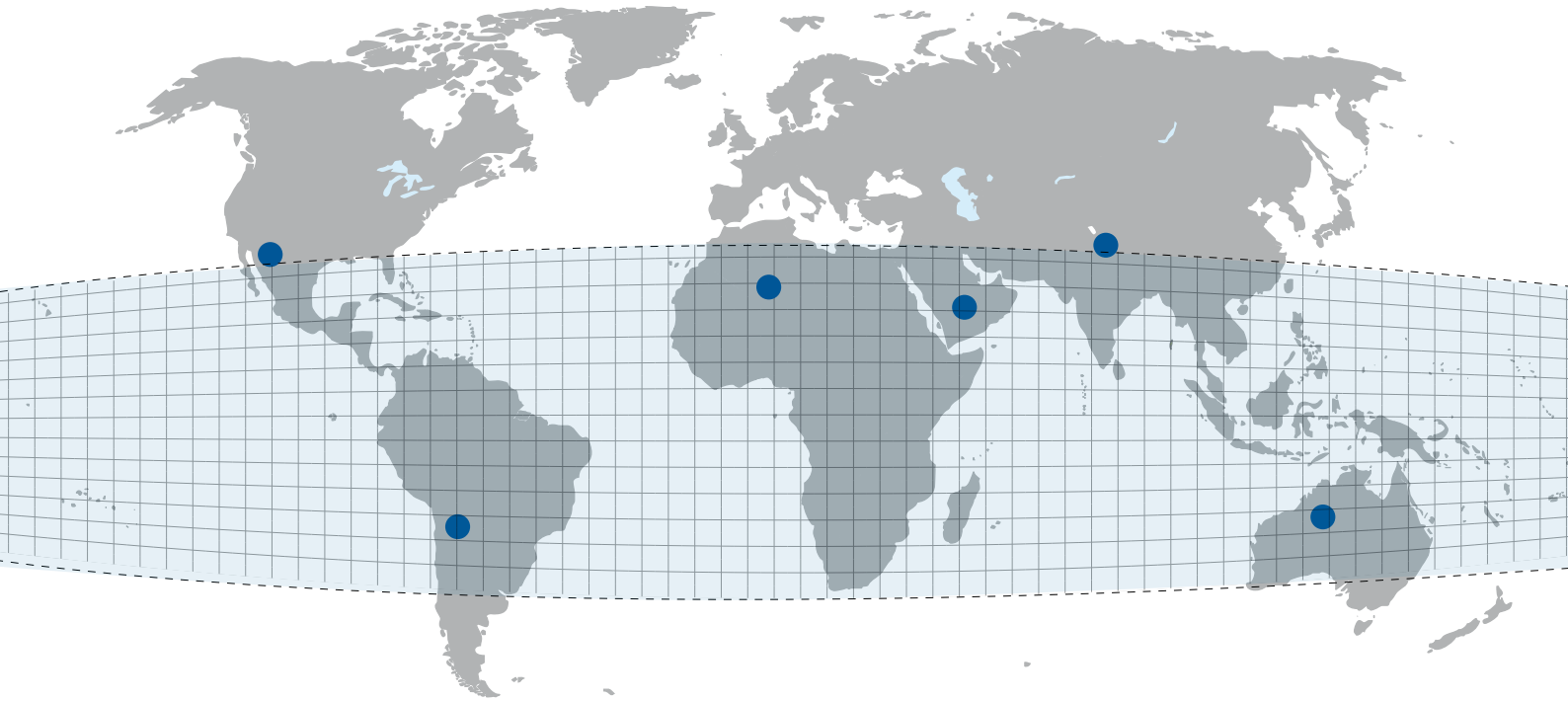
The search for improved efficiency begins at the front, or sunward, surface of the cell, where the average incident

> IT ALL BOILS DOWN TO CPW – COST PER WATT.

solar radiation is about 1000 W/m^2. Though this number is a convenient rule of thumb, it is only an average. At high altitudes or in space, less atmosphere blocks the sun's light. In winter and in the morning and evening, the sun is lower in the sky and less energy reaches the panel. Differences in atmospheric absorption, whether due to location or to weather and pollution, change both the intensity and the spectrum of incident light hitting the panel. These differences affect the economic model for solar energy in fairly intuitive ways: Arizona and New Mexico have access to a much larger solar resource than Washington and Oregon. More subtly, however, atmospheric effects change the performance of particular cell designs.

SEVERAL COMPETING TECHNICAL SOLUTIONS

The structure of a solar cell, or photovoltaic cell, is highly complex. But very simply put, it consists of a combination of layers designed to make photons (light) knock elec-



The most interesting regions in terms of solar power are naturally arid regions close to the equator. The grid represents a zone in which solar energy potential ranges between 200 and 350 watts per square metre. The blue dots show the area of solar panels needed to generate all of the world's energy using 8 percent efficiency (each dot represents 18 terawatts).

FACTS ABOUT SOLAR POWER

- The sun provides us with 10,000 times as much energy as we need.
- Photovoltaic production has doubled every two years since 2002 (average increase of 48 percent a year), making it the world's fastest-growing energy technology.
- World solar-cell production was estimated at 3.4 GW in 2007.
- Solar power contributes with 0.039 percent of the world's electricity needs.
- PV installations in 4 percent of the world´s deserts would meet global energy needs.
- Solar power is currently too costly for widespread consumer take-up.

trons (electricity) into motion. Both the layering and other technical factors decide the efficiency and cost of the cell. Photovoltaic cells are generally divided into three different categories: 1st, 2nd, and 3rd generation. Most prevalent (about 90% of all solar cells) is first, and technically simplest, generation, but both second and third generation are gaining momentum.

NIL OFFERS LIGHT-CAPTURING POSSIBILITIES

The emerging solar power sector faces challenges that are common in new industries. Several technologies are competing to lower cost, and it is not yet clear which will win. One of the challenges cell designers face is the need to improve voltage, current, and fill factor simultaneously. Surface texturing, for example, can introduce surface recombination sites at the same time that it improves light capture.

NIL, nanoimprint lithography, is one of several technologies that show great promise for future development of the photovoltaic cell. The nano-scale structure of the light-exposed surface of the cell is paramount to its efficiency, and obviously also the production cost of solar cell material. Both these facts make NIL a strong contender in the coming years.

It's important to remember that efficiency is less important than CPW. The electricity from all types of solar cells, simple or high-tech, is identical. To succeed, a design must be not only efficient, but cost-effective. At the moment, the most commercially successful designs seem to be those that combine moderate efficiency with low or moderate cost.

Sources: Solid State Technology, World Energy Magazine, Miljöportalen, Wikipedia

SOLAR POWER AND NIL

Nanditha Dissanayake is soon to complete a PhD at the Department of Electronic Engineering at the University of Surrey, UK. His field of expertise includes working on high-efficiency nanocrystal-organic photovoltaic devices; i.e. improving the standard of solar cells. Moreover, he co-wrote the article that wound up in second place in Obducat Prize 2007.

On the preceding pages, you can read more about the promising future of solar power – and Obducat's potential role in it. Obducat InSight also took the opportunity to ask Nanditha a few questions on the subject. Below is a shortened version of the interview.

THE WORLD IS SEARCHING FOR CLEAN ENERGY SOURCES TO REPLACE THE OLD AND DIRTY. HOW HAS THIS AFFECTED INTEREST IN SOLAR POWER?

Fossil resources are finite, with oil, natural gas and coal having reserves up to 40, 56 and 200 years respectively. Demand for electricity will go up, while carbon emissions must be sharply reduced. Nuclear fission may cause low carbon emissions, but can due to other factors hardly be categorised as 'clean'.

Currently less than 0.1% of the world's electricity is produced off solar power, and the foremost drawback to mass-scaling is associated with its higher cost. But even with the higher cost of solar-power generation, there has been staggering market growth since 2000, 20–30% yearly, which gives a clear indication of solar power's potential.

NANOIMPRINT LITHOGRAPHY (NIL) HAS BEEN MENTIONED AS A POSSIBLE MEANS FOR FUTURE, BETTER SOLAR CELLS. HOW?

Nanoimprinting can be utilised as a high-throughput, facile and highly scalable fabrication method for organic and dye-based solar cells. There have been several reports in the past where these techniques are applied successfully for the fabrication of organic light emitting diodes, OLEDs. The same principles can be utilised to engineer photovoltaics devices as well. Furthermore, NIL presents a novel method of texturing active layer surfaces to increase light harvesting by increasing the interfacial area, enabling greater charge separation. NIL can also be used to improve local properties in the microstructure using facile surface techniques. These local properties can result in increased light absorption as well as increase in charge carrier mobility.

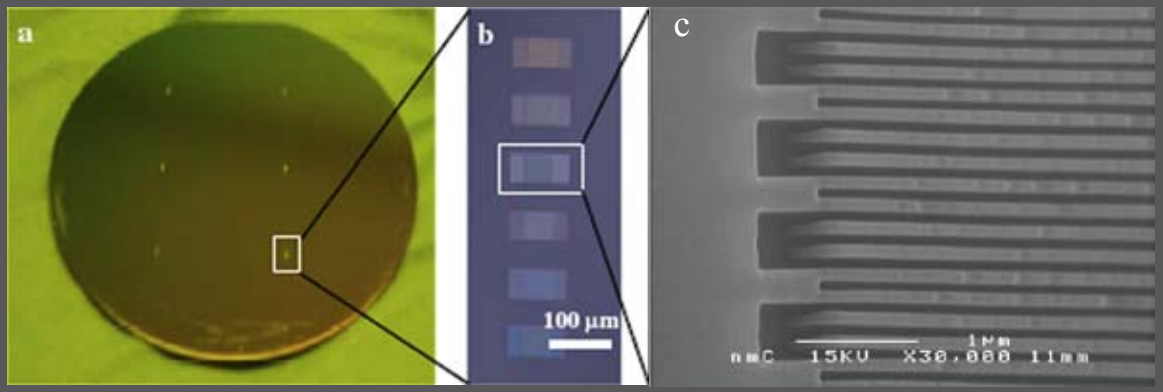
WHAT ARE YOUR PREDICTIONS FOR SOLAR POWER IN TERMS OF IT BEING A SERIOUS LARGE-SCALE ENERGY ALTERNATIVE?

Silicon has to be vastly reduced in cost. Silicon-based solar cells would be the number one contender as the short-term, large-scale energy source. When the current technology challenges are met, organic-based solar cells would compete as the front-running active material. These organic-based thin-film solar cells would then be fabricated at a fraction of the cost of silicon and the large area processability would enable PVs to be the dominant sustainable green energy source in the world.

"NIL IS A NOVEL METHOD TO INCREASE LIGHT HARVESTING.

SMALL THINGS ARE HAPPENING IN LUND

It sometimes seems as if the wonder of nanotech solutions knows no limit. One is led to believe that a nano-related breakthrough is near in just about every aspect of modern life. In reality, things are somewhat more complicated, and the distance from a good idea to a working product can be long. In Lund, however, one such idea is currently in the home stretch.



THE NIMBLE PLATFORM;

a) optical image

b) optical microscope image

c) scanning electron microscope image.

NIMBLE FINGERS

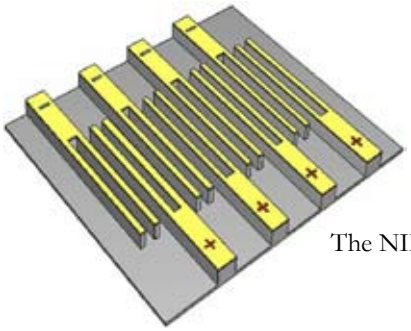
The basis for NEMS AB's work – the acronym NEMS normally stands for nanoelectromechanical systems, which fittingly is its namesake's business niche – is the NIMBle Platform (Nano Imprintable Metallized and Bendable), a concept that combines simplicity with versatility. The basic, patented structure consists of fingers electrically coupled in pairs. By applying an electrical charge, the fingers can be made to bend towards each other, thereby changing their characteristics. Applying an alternating voltage of the right frequency causes the fingers to resonate.

DETECTOR APPLICATIONS

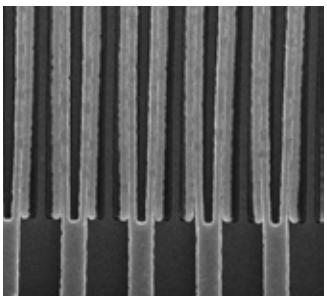
The main focus for the technology development at NEMS AB has so far been a mass-sensitive sensor for detection of airborne chemicals. The principle is that an added mass causes a shift in the resonance frequency of the structures. The NIMBle structure can this way offer an unparalleled sensitivity for e.g. explosives or viruses.

THE OBDUCAT ANGLE

NEMS AB has developed the NIMBle technique by using NIL (nanoimprint lithography) technology and equipment from Obducat. Since the fingers are fixed lengthwise at the bottom, the structures can be imprinted into a polymer, using NIL. For electrical contact, a metal, such as gold or aluminium, is then added on top without any additional patterning. This way the fabrication process can be kept both functional, cost-effective and is possible to scale to high volume manufacturing.



The NIMBle Platform.



The structure fingers at maximum deflection.

Q&A

PETER & MIKAEL

PETER GÖRANSSON began working at Obducat as recently as September of this year. Before that he worked for Micronic Laser Systems AB as Service Manager – the same position he holds at Obducat – and a brief stint at Sony Ericsson. He is responsible for the installation, service and support of Obducat's machines.

1. WHAT PROJECTS ARE YOU INVOLVED IN AT THE MOMENT?
For me, it's a lot of Sindre 60. Another big assignment is preparatory work for planned HVM deliveries early next year.

2. ANY SIGNS OF CHRISTMAS AT OBDUCAT?
I have 4 machines to install before Christmas (as of November) – ask me again when that's done!

MIKAEL EKHOLM joined Obducat in August 2008, having previously worked at AstraZeneca R&D and Ericsson Microelectronics. As Facilities Engineer, his responsibility is to keep the process laboratory up and running according to Obducat's requirements.

1. WHAT PROJECTS ARE YOU INVOLVED IN AT THE MOMENT?
My main task is to take care of critical parts of the equipment. I'm also involved in particle-reducing actions to achieve a desirable uptime for the tools, as well as improving process repeatability. Increased safety is another important, continuous issue.

2. ANY SIGNS OF CHRISTMAS AT OBDUCAT?
My family and I are healthy, and we just moved to a nice place not far from Obducat. To me, that's a Christmas gift as good as any.

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