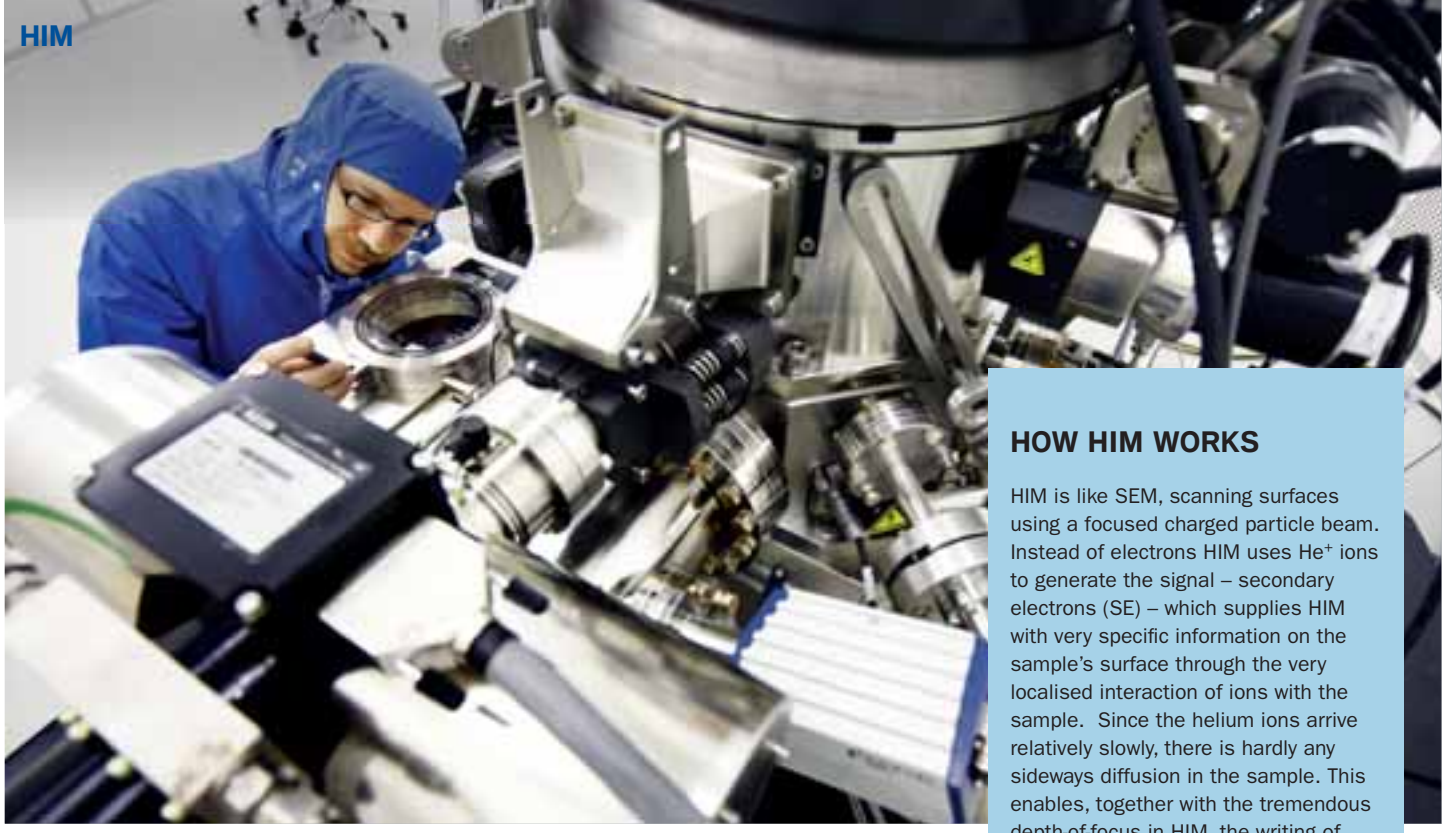

Photo: Sam Rentmeester

Read and write with helium ions

'All our customers return,' says Dr Diederik Maas, TNO's scientific brain behind the Helium-Ion-Microscope, or HIM. Hardly surprising given the very sharp, practically undistorted images that HIM makes of almost every conceivable material. And in the HIM there is no need to coat the samples for insulation as you have to do for electron microscopy (SEM).

HIM – you can use it to read and write. Let's start with 'reading'. For example, we have successfully made crystal structures in the organic solar cells of the Holst Centre visible, which is crucial for the yield of those cells. Maas: 'No other method can do that.' Another example is making grain boundaries in steel visible without charging. Maas: 'In ten minutes you can produce a snapshot that you cannot get even after hours of work in the SEM.' Soft materials, too, like crackers and milk powder, can be imaged with unprecedented resolution since HIM has such a good contrast for light elements.

The drawback of HIM is that it is not yet really possible to analyse materials, let alone quantify them. So HIM really complements rather than competes with SEM. Maas: 'I see many applications in food and pharmacy, lithography and catalysis – all strong Dutch industrial sectors.'

NANOSTRUCTURES

In addition to reading, HIM can also write, with unprecedented resolution. TNO and TU Delft have co-developed two methods to make nanostructures using HIM. By illuminating a photosensitive layer pins of 5 nm are written at a distance of 14 nm from each other. Which is quite something: such tiny structures so close together. This is made possible by the extreme sharpness and brightness of the helium ion source and because the ions are deposited at low speed. The ions hardly diffuse sideways so this allows patterns to be made with a high degree of density. The equipment maker Raith is involved in this development.

For Zeiss, the supplier of HIM and long-term co-development partner of TNO in this, an alternative method of writing has been investigated whereby metals are deposited from a precursor gas. Such methods are especially suitable for the rapid and secure manufacture of prototypes of new nanodevices and photonic crystals. Although HIM has not even been at TNO for a year, the instrument is already in use eighty per cent of the time. Maas: 'Every week we are astounded by the possibilities.'

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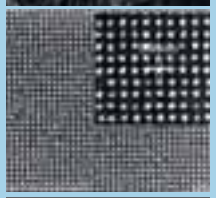
HOW HIM WORKS

HIM is like SEM, scanning surfaces using a focused charged particle beam. Instead of electrons HIM uses He^+ ions to generate the signal – secondary electrons (SE) – which supplies HIM with very specific information on the sample's surface through the very localised interaction of ions with the sample. Since the helium ions arrive relatively slowly, there is hardly any sideways diffusion in the sample. This enables, together with the tremendous depth-of-focus in HIM, the writing of high-density patterns with ultrafine details. The charge of insulating sample surfaces in HIM is much smaller than in SEM, and after each line scan neutralisation is just a matter of a puff of low-energy electrons. This makes coating samples, which is the case for many an artefact, superfluous.

Never imaged before, these crystal structures in the organic solar cells of the Holst Centre.

Corus saw the grain boundaries in steel really clearly for the first time.

Unilever crackers: never before such a sharp image without coating.



Pins of 5 nm on a 14 nm pitch, effortlessly written by HIM.

HIM writes patterns directly using a precursor gas, fast and secure.