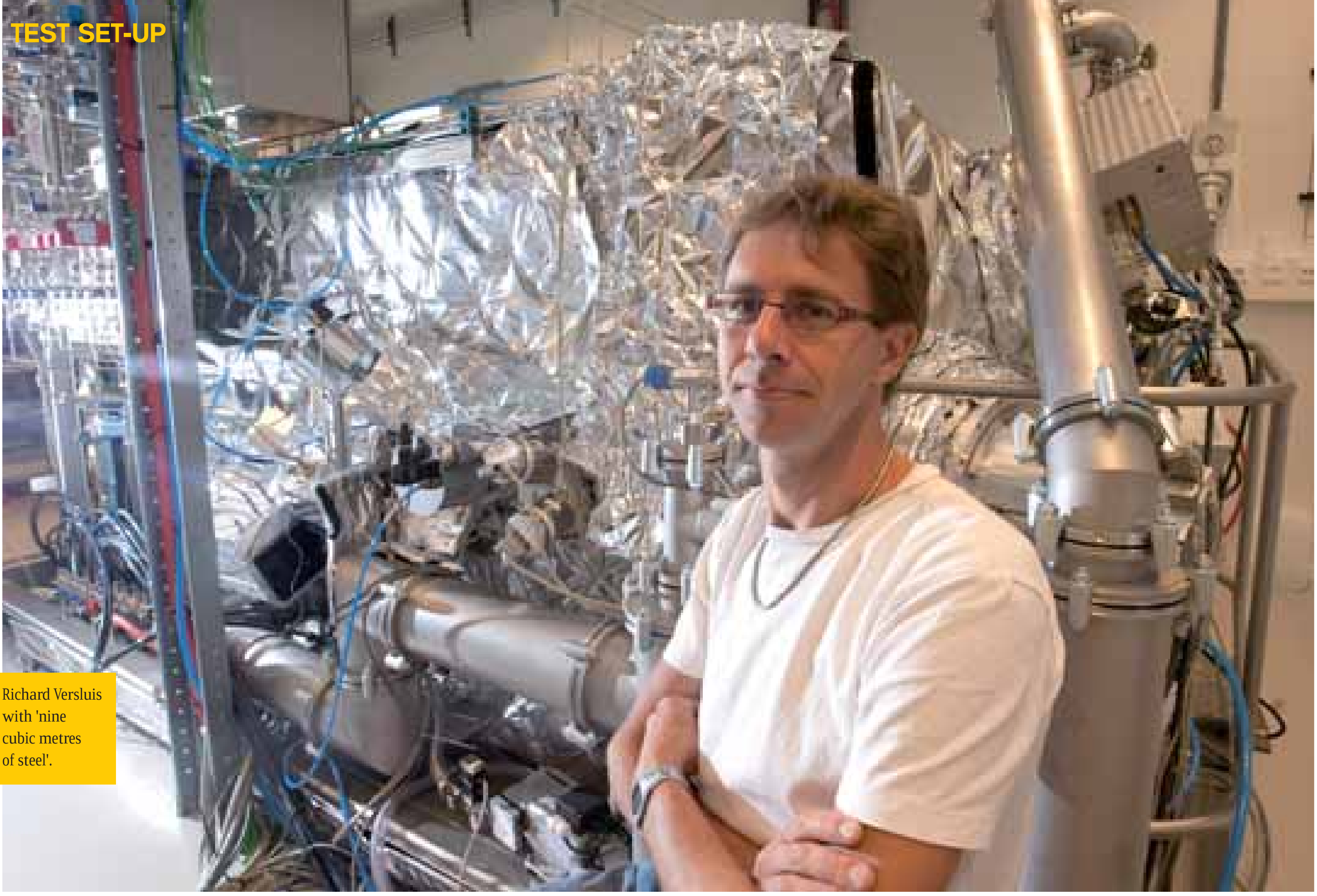

Richard Versluis with 'nine cubic metres of steel'.

Photo's: Jaap Oldenkamp

Dynamic Gas Lock works

There is a remarkable paradox in physics: the smaller the object you study, the bigger the test set-up has to be. The measuring instrument recently built at TNO can only just squeeze through the double lab doors. Its job is to measure the negligible gas flows in a vacuum system.

The customer for the test set-up is ASML, supplier of the wafersteppers that form the heart of the manufacturing of IC's and memory chips. These machines write intricate structures onto wafers, thin silicon sheets 300 mm in diameter. ASML leads the world in wafersteppers because it can write the thinnest lines (38 nanometers) at the highest speed: up to 140 wafers per hour. Equivalent to marking all the roads in Germany in less than half a minute.

ASML is continuing to develop its wafersteppers in order to stay ahead of the field. The basic principle is unchanged: light reduces a pattern from the screen to a wafer on which the pattern of lines is burnt into a photo enamel. The more shortwave the light, the smaller the details that can be transferred. The original green light standard is now 193 nanometer ultraviolet (UV) and the next step will be Extreme UltraViolet, EUV, or 13.5 nm.

GAS FLOW

But EUV is absorbed by all materials – it does not escape anything. So instead of lenses, mirrors are used. And instead of inert gas the system requires a vacuum. Which makes a current problem that much trickier. The flue gases of the burnt photo enamel can precipitate on the lenses and turn them black. EUV is highly sensitive to this: an atomic layer of contamination on the mirrors means that too little EUV arrives at the photo enamel. And in a vacuum the flue gases drift unhindered to the mirrors and precipitate immediately on them.

System engineer Richard Versluis explains the TNO solution. 'A gas flow that physically separates the mirrors from the dirty wafer, yet lets enough EUV through.' This is known as a dynamic gas lock (DGL). TNO made a flow calculation and even developed models for this in order to substantiate the principle and built a test set-up that provided the experimental proof that the separation worked well. A DGL was then successfully incorporated into the prototype of the EUV waferstepper.

However, for the actual production machines the DGL has to be improved a thousandfold. Again, experimental proof was needed, not just for the separation by the DGL but also for temperature and vibration control. ASML and TNO developed a new set-up in just over a year and demonstrated that the suppression could be achieved. This required an extremely clean test set-up, cleaner than electron microscopes normally are, for instance. Project leader Michael Dekker: 'To ensure that the vacuum vessels are leak-proof they had to be lowered over a welder and welded from the inside.' And the entire set-up – 4 x 1.5 x 1.5 metres – regularly heated up to 150°C to vaporise the residual contamination. So, Versluis sums up, 'nine cubic metres of steel to test a component of 10 cubic centimetres...'

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