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Bonded seals for miniature sensors

The National Oceanography Centre (NOC) in Southampton is one of the foremost institutions of its kind in the world, and among its on-going projects in recent years has been the creation of miniaturised sensors to directly measure changing nitrate levels in rivers and oceans, and variations in ocean acidity caused by increases in atmospheric CO_2.

The 3.3mm diameter piston operates in a boroslilicate glass cylinder

To achieve this with the accuracy and resilience required, their latest microfluidic sensor needed the 3.3 mm diameter pump cylinders and pistons to be sealed to an exceptionally stringent standard – something which conventional o-rings and quad rings proved incapable of achieving.

With an endurance target of 100,000 cycles, a bonded sealing element was proposed, and in October 2012, DP Seals were briefed on this vital component.

FFKM the first choice

Considering the environment in which the sensors might operate – where high pressures, fluctuating chemical properties and very low temperatures could all be critical factors – it soon became clear that only a seal made from FFKM perfluoroelastomer would meet NOC's requirements.

While many companies believe FFKM is difficult to mould and unjustifiably expensive to produce, we knew from our previous work with the material that it not only had the outstanding characteristics essential for predictable performance and total reliability, but could also be successfully produced to a realistic budget and within a sensible time scale.

An 18-month programme ensued and initial samples were produced, but tests showed that fluid leaked past the seal after less than 2,000 cycles – so further samples with improved surface quality and less mould artefacts were made and bench-tested in NOC's labs. This time there was no leakage at all until 75,000 cycles and only a slight loss of performance at the 100,000 target.

Increasing the seal diameter to eliminate the leak entirely proved to be a red herring, and after some issues with stray bonding agent were successfully resolved,

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the first production batch of seals was delivered and fitted. On-going bench testing at NOC has recently achieved 178,000 trouble-free cycles, far in excess of the 100,000 cycle target. "This is a fantastic result and marks a step-change in reliability for our sensors" remarked NOC's Kevin Saw.

Eyes on the prize

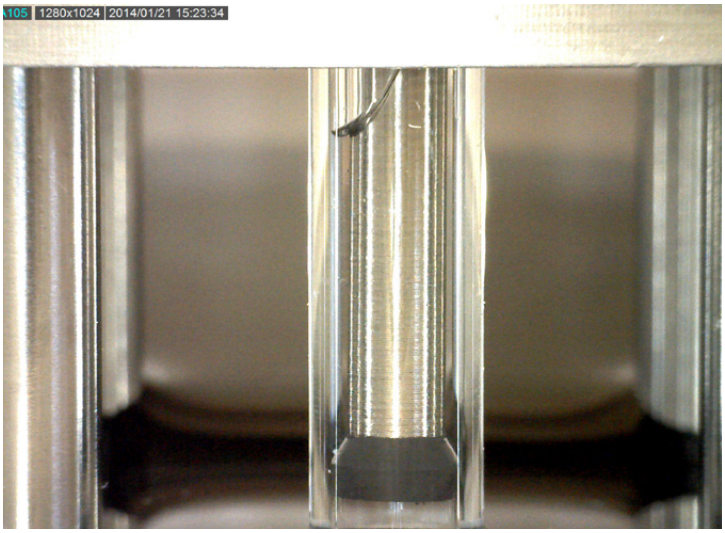
In early 2014, the new oceanic sensors – complete with seals – took part in the prestigious Wendy Schmidt Ocean Health XPrize, in which 23 organisations from around the world are competing for a $2 million prize, and having successfully passed Phase 1 of the competition, the NOC team moved into Phase 2 in September.

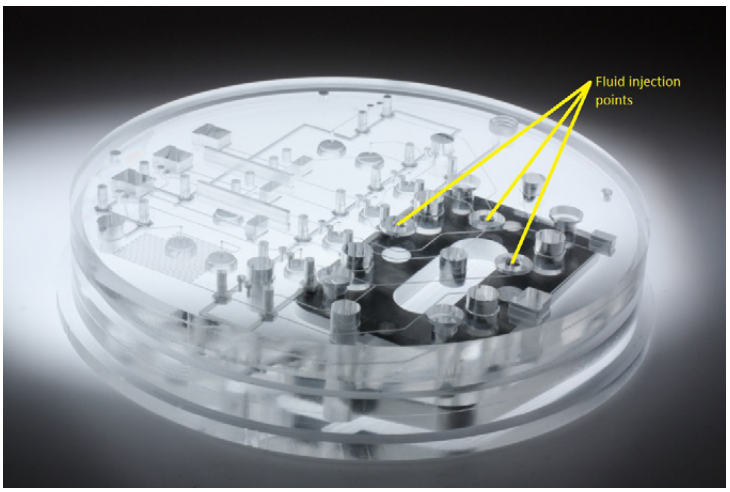
In addition, a nitrate sensor deployed in the Hampshire Avon has completed 25,000 cycles over a ten week period without any problems – and gathered very good data in the process.

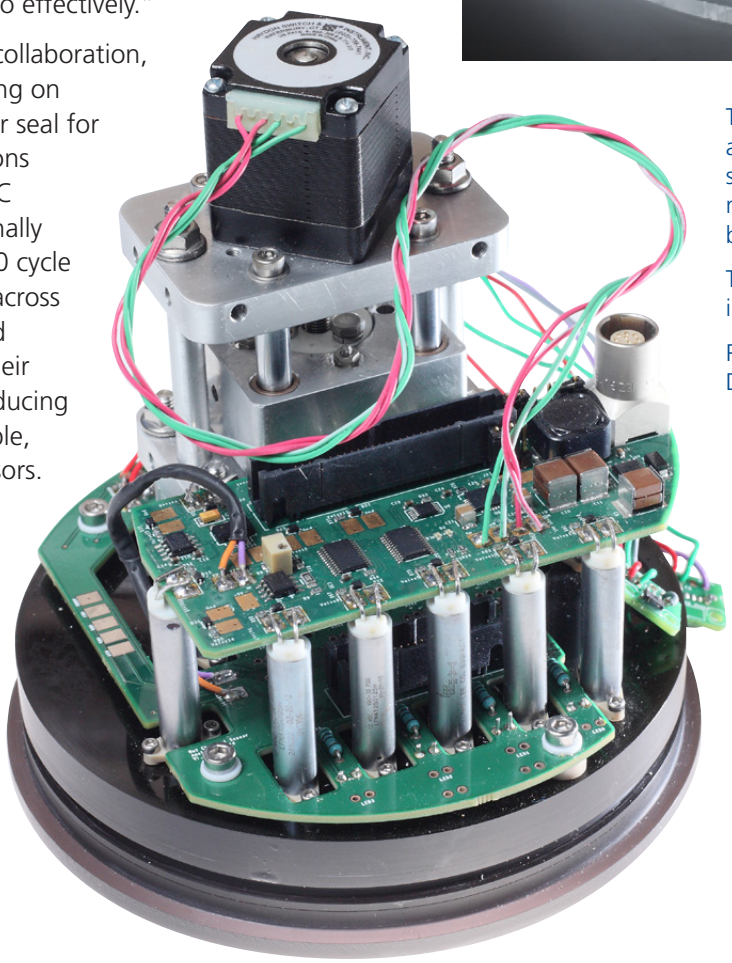
Kevin Saw was quick to credit the role we played in the project.

"It's the first time we've worked with DP Seals," he said, "and we were hugely impressed by their understanding of our requirements, their insights into materials selection and their ability to meet our brief so effectively."

As a result of this collaboration, we are now working on tooling for a similar seal for larger 9.8mm pistons and this offers NOC real potential to finally achieve its 100,000 cycle endurance target across their full range and further enhance their reputation for producing exceptionally reliable, world-leading sensors.







The 3.3mm diameter piston operates in a boroslilicate glass cylinder, obtaining sample fluids and processing them in the miniaturised sensor located in the cylindrical base of the unit shown above.

The unit can be used in any of the NOC's impressive fleet of gliders and mini-subs.

Photography credits: Kevin Saw, NOC and David Owsianka, NOC.

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