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SPECIAL FEATURE

# A hard act to follow

**Liz Nickels and Kathryn MacKenzie**

**What happens when a finished part needs a super hard coating, but thermal spraying just won't cover it? Liz Nickels paid a visit to Hardide Coatings in Bicester, UK and found out how a Cold War tungsten coating technology has become one of the most effective ways to make the whole surface of complex metal components extra hard.**

The technology behind Hardide Coatings' chemical vapor deposition (CVD) technology has an interesting history, originating as it did in the pre-perestroika Soviet Union. Technical director, Yuri Zhuk, tells the story. 'Materials in general were one of the priorities in the Soviet Union – because for electronics or space sputniks or nuclear reactors you need materials with special properties,' he explains. 'The space race required very extreme materials, capable of withstanding extreme temperatures, extreme loads and so on. So at the time there was quite a lot of innovation and new developments in materials–but very little of that was commercialized, due to Cold War secrecy.

'As a result, there was a risk that this research would never be published, and that potential users would never know that such wonderful technology exists. However, this situation changed in the early nineties with the collapse of the Iron Curtain – but then funding for research institutes in the former Soviet Union was dramatically cut. As a result, researchers were allowed and even encouraged to find commercial use for their technologies. So that's how it started.'

Coated and uncoated TSP diamond inserts.

Hardide Coating's CVD technology is a way of producing a coating based on tungsten carbide that, unlike thermal spraying techniques, allows the coating to be completely pore free, and combine hardness with toughness, as a result, extremely abrasion, corrosion, and acid resistant.

'We tried for a number of years to find commercial uses for the technology within its country of origin, approaching companies working in the oil and gas sector and so on – but at that stage they were not prepared to take the risk of developing something new,' Yuri explains. 'The industry was not in a good state then and perhaps they thought to themselves: 'Well, it's a wonderful material but can it be produced consistently, where can it be used, how will it be applied?' At the time, quite significant work needed to be done to commercialize it,' he admits. 'At the same time there were investors in UK who were very interested in the technology, including Lucius Cary, who is considered one of the founding fathers of the UK Venture Capital investment industry. He agreed to fund half a million pounds to kickstart the commercialization, as long as the company was founded within thirty miles from Oxford city centre. By then, the technology had been patented internationally and JCB was the first commercial customer to test the coating. We also attracted a lot of interest from the oil and gas industry – which has a lot of problems with wear, abrasion, erosion and corrosion. So with that investment we built the first pilot CVD machine in the UK to make our particular process.' Two larger

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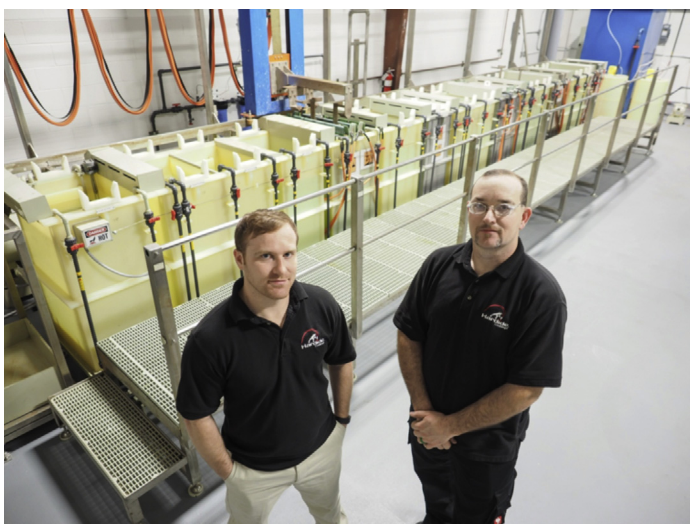
A Hardide reactor being loaded.

industrial-scale CVD reactors were designed and built later when the demand for the coating grew, and most recently in October 2014 the company invested a six-figure sum to install a third large capacity reactor at its plant in Bicester, Oxfordshire.



Jamey Ewing, coatings supervisor and Barry Farmer, pre-treatment supervisor (right), the first two senior employees at the facility in Virginia, USA.

## Complex shapes

I asked Yuri how the technology stands out in the coatings arena. 'It's not the only coating on the market but it does fit very neatly into the landscape of other coating technology. And it can do what most other coatings cannot do,' he explains. The technology's USP is that it can coat complex shapes as well as internal and external surfaces. 'Why is it important? Because many of the currently used coating technologies can only be applied to external surfaces,' Yuri says. 'For example, plasma or thermal spray can apply a very hard particle material to the surface of a part – building a very thick layer. However, it can only coat the external of a simple shape such as a cylinder, a flat or a sphere, because the spray gun needs direct access to the surface being coated to scan it building up layer by layer. As well as this, the spray cannot be allowed to get too close to the item because then it will essentially melt steel. It will overheat steelwork so there are some technical restrictions to this.'

According to Yuri, critical components coated with Hardide coatings could last three or four times longer during very abrasive, very corrosive duties. 'From the field tests we know that the life of the critical components have tripled or quadrupled,' Yuri claims. 'So it means that it's not just a small percentage increase – it can be a significant increase in life. Some of the tools for oil drilling operations can be very expensive, especially factoring in downtime costs. If a tool fails when it has drilled to a depth of a couple of kilometres, it has to be replaced. It might be necessary in this case to extract a two kilometre length of piping from the hole, replace it and then push the piping back, which is not a simple operation, so engineers might have to start from halfway through the operation again. Replacing the tool can take a day, that can easily cost again half a million pounds in direct costs, salaries, lost production even for that short time. So extending the life of the tools can save a lot of money for oil drilling operators.'

Yuri says that the coatings can also be extremely thin. 'The thickness can typically range from between five to a hundred microns. There are many coatings which are below five microns; there are many coatings which are more than a hundred microns: but not many can do something in between,' he claims. 'And the reason why it's very useful, thickness wise, is that you need sufficient thickness to withstand load. On the other hand, if you make a very thick coating then it will distort the part dimensions and tolerances.' Something around the fifty microns range can provide sufficient thickness to withstand loads but is thin enough to allow the accurate dimensions of the parts.

According to Yuri, the company's Hardide T material is in the middle of the Hardide coatings hardness range and reportedly delivers the best results when used for the oil industry and in pump and the valve applications. The aim was to make a material which is harder than sand, an abrasive material which is present in oil and car engines, as well as aircraft engines and hydraulic components.

Hardide coated bushes for aerospace applications.

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