15 September 2017

HARDIDE PLC

CHEMICALS

HDD.L

1.75p

Market Cap: £26.9m

SHARE PRICE (p)

12m high/low	2.2p/0.7p

Source: LSE Data

KEY INFORMATION

Enterprise value	£25.7m
Index/market	FTSE AIM
Next news	FY Sept 17
Gearing	0%
Interest cover	N/A

HARDIDE IS A RESEARCH CLIENT OF PROGRESSIVE

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Ready for Take Off

Over the last 6 months Hardide plc has been benefitting from an improving outlook in its largest key market (Oil & Gas), receipt of Airbus supplier approval and NADCAP accreditation, patent approval for its ground-breaking coating technology for diamond applications and order momentum within its precision engineering segment. Its revenue prospects look to have reached an inflection point resulting from this positive traction.

- Hardide plc is a world leader in low temperature chemical vapour deposition (CVD) tungsten carbide coatings. Its characteristics display wear, corrosion, fatigue and galling properties that are superior to other alloy coating technologies such as hard chrome plating (HCP) or thermal spray techniques like high velocity oxy-fuel (HVOF) or physical vapour deposition (PVD).
- Its technology offers clients lower costs through the potential to use cheaper substrates, lengthen life cycles, lessen down times and lower the risk of failure.
- Gaining approved supplier status with Airbus and the receipt of the NADCAP accreditation signal a step change for Hardide. We expect material aerospace orders to emerge within the next 12-18 months, which will be positive for margins and serve to further diversify group revenue.
- Across the group, Hardide's near term revenue prospects are supported by positive contract momentum across all segments, as well as a continued recovery in the Oil & Gas market, projected economic growth in its two main geographies (UK & US) and continued buoyancy in the Aerospace & Defence market.
- We believe Hardide plc offers investors exposure to a unique technology in the high performance engineered coatings sector, which has near and long term upside as an independent company or part of a larger group. We would encourage investors to meet management to gain a further appreciation of Hardide's prospects.

FYE SEPT (£M)	2016	2017E	2018E	2019E	2020E
Revenue	**2.1**	**3.2**	**4.1**	**5.0**	**6.0**
Adjusted EBITDA	**(1.3)**	**(0.7)**	**(0.4)**	**0.1**	**0.7**
Adjusted EBIT	**(1.7)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
Fully adjusted PBT	**(1.5)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
Free Cash Flow	**(1.9)**	**(0.8)**	**(1.1)**	**0.0**	**0.4**
EV/Sales	**8.1**	**8.0**	**6.3**	**5.2**	**4.3**

Source: Company Information and Progressive Equity Research estimates. IFRS

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Executive Summary

Technology Overview

Hardide plc is a world leader in low-temperature, chemical vapour deposition (CVD) of nanostructured tungsten carbide coatings that extend the life of critical parts and tools. Its patented process is unique, particularly because it can be applied internally and externally to complex geometric shapes. Hardide operates in the High-Performance Engineered coatings sector of the market and has developed a series of coating variants for multiple applications within the oil & gas, flow control, precision engineering and aerospace and defence markets.

The low temperature CVD process creates a hard and thin nanostructured layer of tungsten/tungsten carbide with superior performance in respect of wear, corrosion, fatigue and galling when compared with other alloy coatings such as hard chrome or thermal spray techniques such as high velocity oxy-fuel (HVOF) or physical vapour deposition (PVD). Its pore-free structure provides a very high degree of resistance to chemical attack. Hardide's coating has proven to be 12 times more resistant to wear and corrosion than Hard Chrome plating (HCP). The gas phase deposition results in a uniform coating both internally and externally and can be tailored to produce various degrees of hardness. The process requires no binder and so has a less-bulky structure than alternative technologies and reduces the incidence of galling. It also allows a wider choice of substrate. Its toughness and flexibility substantially reduce the risk of cracking and its effect on fatigue life has been measured as between -10% to +10% versus a deficit of between -20 and -60% that is common for other technologies.

Key Markets

Hardide sells predominantly into the United Kingdom and North America. Both of which appear to be in good economic health. Forecasts for both the UK and the US, over the period which our estimates span, are encouraging with the IMF forecasting the US to grow above its long run average at 2.1% and the UK to grow at 1.7% in 2017E and 1.5% in 2018E.

Its key market segments are oil & gas (O&G), flow control, precision engineering and aerospace & defence (A&D). Within these, O&G activity appears to be robust, with the Baker Hughes Rig Count showing the North American rig count for August 2017 up by 425 rigs (c.90%) compared with August 2016. Of more importance to Hardide is the count for directional drilling, which stood recently at 796 versus 379 a year ago. O&G remains Hardide's largest market by revenue, although dependency on it is now decreasing. As the market continues to develop increasingly-complex technologies, demand for Hardide's coatings from both the O&G and flow control segment is growing.

Significant strides have been made in diversifying Hardide's end market mix with the recent Airbus and NADCAP accreditation. The A&D market is in rude health, with civil OEMs having c.10-year order books supported by growing airline demand for new, fuel-efficient platforms and increasing growth in air travel. The global defence market is in an upcycle with budget expansion in key markets against a backdrop of increasing geopolitical instability. A&D presents a large opportunity for the group. Its technology been proven to be a very good substitute for both hard chrome and HVOF, which currently are used extensively in the industry. The timing of its accreditations is fortuitous as A&D companies migrate away from hard chrome ahead of the impending EU REACh directive. The directive calls for the retirement of the use of hard chrome as an industrial coating because of its toxic manufacturing process. (Note: 21st September 2017 is the sunset date but is subject to an extension which is waiting the approval of the EU parliament).

Hardide has been experiencing significant momentum over the last six months within precision engineering. It has recently won high-resolution X-ray anode work for airport baggage screening machines, gained approval by Royal Mail as a coating provider on its sorting machine components and has on-going trials with various German OEMs for its coatings to protect tooling and parts of plastic extrusion equipment against wear and chemical attack. Hardide recently received patents for its diamond coating process, which is a unique and exciting technology for the oil drilling and cutting-tool industries. The group is also greatly encouraged about its prospects in the power generation sector where it sees multiple applications in both nuclear and conventional energy generation systems. Hardide's coating can extend the service life of blades and avert expensive downtime and failure. The installed base for gas and steam turbines is vast and represents a very large addressable market.

Financials

We have included financial forecasts in summary on the front page of this note and these are explained in more detail on page 20. A key feature of our estimates is considerable growth in revenue supported by recent contract orders, a continued recovery in the Oil & Gas sector and the anticipation of orders resulting from its recent Airbus and NADCAP accreditations. To provide capacity to meet the revenue estimates, we have forecast continued material capital expenditure, with the heaviest capex in 2018. As can be seen from our estimated positive adjusted EBITDA in 2019, Hardide has a high operational gearing because of its low level of incremental COGS and relatively stable fixed cost base.

We believe we have been realistic in our estimates, given the momentum the group is experiencing. For completeness, we have included a Risk section on page 23 which explores the risks to the group that could hinder achievement of our estimates.

Conclusion

Hardide plc offers a unique and potentially disruptive technology in the coatings markets but is not yet widely understood by potential clients or investors. It has been actively seeking to educate the Industrial community about the superior characteristics of its coatings. By way of accreditations and R&D leading to coating variants Hardide has been working hard to expand its exposure to key markets. These efforts are now resulting in increasing financial momentum.

We would encourage investors to meet the Hardide's management to gain a greater understanding of its technology and of its prospects.

Company History

The Hardide coating technology was developed at Moscow University and the Russian Academy of Science Institute of Physical Chemistry. The company was incorporated as Hardide Coatings Limited (HCL) in 2000 to further develop the Hardide technology. In 2003, the company opened its 12,500-square foot facility in Bicester, Oxfordshire and in 2005 listed on the UK AIM market.

Hardide currently operates its original plant in the UK (Bicester), which houses three large and one small coating reactors. In addition, in 2016 it opened a modern 26,000-square foot facility in the United States in Martinsville, Virginia. This became operational in February 2016 and now houses two large coating reactors. The North American region is expected to be a high growth area and so the new facility allows for considerable expansion of capacity with room for at least three more coating reactors.

Since its admission to AIM, Hardide has undertaken several fundraisings to support its growth, with the most recent in 2016 where it raised £1.6m (200,202,000 shares at 0.8p).

Hardide Technology

Hardide plc is a world leader in advanced CVD tungsten carbide coatings. Hardide's coatings significantly increase the working life of metal components operating in abrasive, corrosive and chemically-aggressive environments. Its products allow its customers to reduce downtime and increase productivity, thereby leading to enhanced overall performance and lowered operating costs.

Hardide uses a method known as chemical vapour deposition (CVD). This process is unique in its ability to be applied both internally and externally to complex geometric shapes. As many end-market applications require more-complex parts that operate in increasingly demanding environments, the Hardide technology is truly an enabling technology.

Its coating process results in extreme hardness and toughness combined with ductility and impact resistance. This combination of properties reduces markedly the effects of wear and corrosion, and inhibits micro-cracking. Its coatings can be used on steel, hard alloys and other materials.

- Hardide is the only company to have successfully commercialised low temperature CVD for tungsten carbide coatings.

The Hardide process starts with the inspection and measurement of customer-supplied components. These are then treated in a series of chemical baths. A sublayer of nickel having been applied, the components are loaded into the low temperature coating reactor and heated to approx. 500ºC (conventional CVD processes operate at c.1000°C). Once at the desired temperature for the given application, a controlled mix of gases (the primary one is tungsten hexafluoride) is pumped into the furnace. This is the CVD method. The coating crystallises atom-by-atom from chemical reactions of the gases onto the surface of the component, leaving a thin, uniform, conformal and pore-free, binder-free layer of nanostructured tungsten and tungsten carbide. The resulting dense and homogenous coating layer has high resistance to wear, abrasion and chemical attack. Another unique feature of the coating is that it follows exactly the profile of the uncoated part (conformal), so that usually no further machining is usually needed. The final product is then polished, tested and re-measured to ensure it has the required dimensions before shipping back to the client. The typical turnaround time from receipt to shipment is four weeks, but can be much quicker if required by the customer.

Hardide is the only company to have been successful in commercialising low temperature CVD for tungsten carbide coatings

The range of Hardide coatings in the exhibit below have been developed as the company has sought different end market opportunities. The coatings can be varied from pure tungsten to pure tungsten carbide – the actual proportion depending on the end application and properties required. The most recent developments are Hardide-A for aerospace and Hardide–D for diamond applications.

Hardide Coatings

Type	Hardness	Toughness	Thickness	Application
Hardide-H "Ultra-Hard"	3000-3500Hv	Satisfactory	1-5µm	Self-Sharpening cutting blades
Hardide-M "Multi-layer"	1200-2000Hv	Good	Typically 50µm	Erosion resistance
Hardide T "Tough"	1100-1600Hv	Excellent	Typically 50µm	Oil tools, pumps, valves, actuators
Hardide A "Aerospace"	800-1200Hv	Excellent	50-100µm	Hard Chrome and HVOF replacement
Hardide W	400 Hv	Excellent	up to 300µm	X-ray anodes
Hardide -D	up to 2500 Hv	Excellent	up to 50µm	Adhesive protective coating for industrial diamonds

Source: Company presentations

Patents

Hardide has patented its technology. It currently holds five families of patents, which typically last 20 years. Two protect the composition, structure and deposition methods of the different types of Hardide coatings for metal parts. The coating's chemical composition leaves a unique "fingerprint", therefore the patent over its composition may to be used to defend rigorously its intellectual property.

There are two further patents for its diamond coatings. One was granted in March 2000 and another for further patented developments in March 2013.

Hardide is continually making advances and developing additional technologies for which the company will seek to patent. The trademark 'Hardide' was registered in the EU in 2002 and in the United States in 2005.

The management of Hardide has created a board-level Intellectual Property (IP) Committee and this meets quarterly to review and develop the company's policy on IP.

Competing Coating Technologies versus Hardide

Hard Chrome

One of the more-traditional coatings used in industrial applications is hard chrome. This is a method whereby an electric current is used to deposit a thin layer of chromium onto a metal object. The objective is to make it harder, more corrosion resistant or reduce friction. The process of hard chrome plating uses hexavalent chromium salts, substances that regulations imposed by EU REACh will prevent the use of after the 21st September 2017. This because it is carcinogenic. However, the Aerospace and Defence industry has lobbied vigorously for an extension to the sunset date with the result that a 7-year extension with restrictions has been recommended for certain applications, but this is currently awaiting EU Parliamentary approval.

- The future use of HCP has been prevented by the EU REACh directive

Hardide-A is a direct substitute for hard chrome and has been shown to be 12 times more wear resistant than hard chrome and displays a higher resistance to acids and corrosion. Hardide-A conveys a minimal fatigue debit of between -10% to +10%. This compares very favourably with other hard coatings that have a fatigue deficit of up to 60% in some instances. In tests, Hardide-A coating has proven to have self-smoothing properties and resistant to galling and adhesive wear. Companies using hard chrome plated components have been migrating away from the technology in anticipation of the impending regulation.

Physical Vapour Deposition (PVD)

PVD is a process that evaporates a target material using magnetron sputtering, electric arc or other techniques, and then condenses the vapour on the parts being coated. PVD can produce a very hard layer, but with limited thickness (just a few microns) and thus limited load-bearing capacity, and is also a line-of-sight technique making it unviable for internal surfaces.

The Hardide CVD process has many benefits over PVD. It allows complex geometric shapes to be coated externally and internally whilst PVD only allows surfaces to be coated that are in 'line of sight'. The unique properties of the Hardide coating can allow customers to choose lower-cost substrate materials instead of making the components out of expensive alloys, at the same time as achieving a better in-service performance. The Hardide coating is also non-porous. This is unlike PVD coatings which are porous and therefore expose the substrate to corrosion.

High Velocity Oxy-Fuel (HVOF)

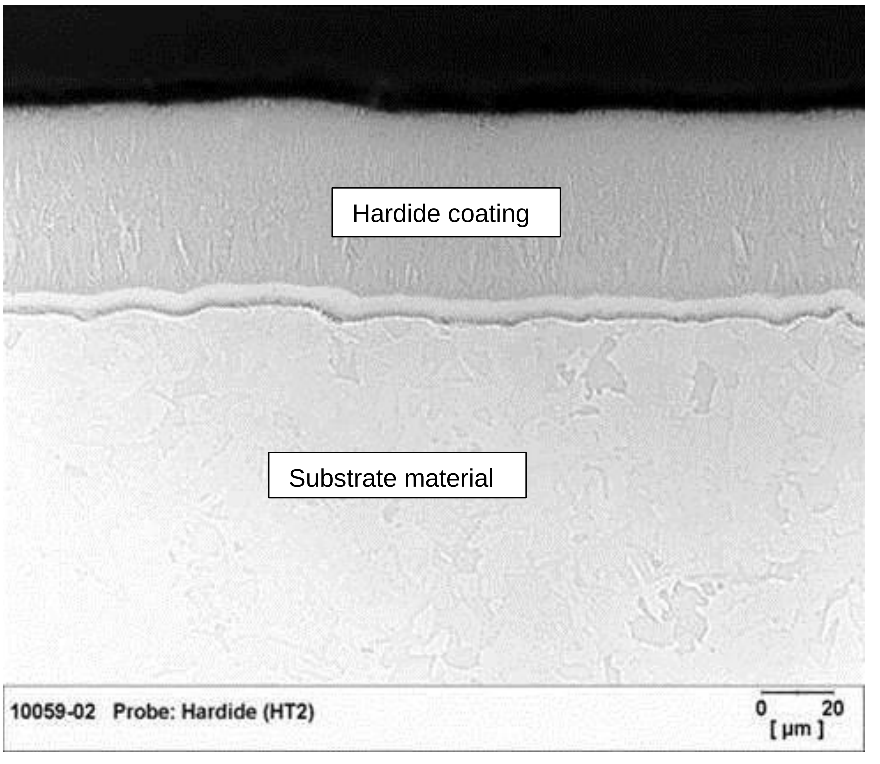
High Velocity Oxy-fuel (HVOF) is a thermal spray method that mixes oxygen with hydrocarbon gases or liquid fuels together with a binder material in a combustible environment. The low temperature method sprays the melted coating particles at near supersonic velocities onto the substrate, creating a hard coating.

HVOF is a 'line of sight' coating and requires grinding after coating. The Hardide coating does not requires this and therefore is highly suitable for complex shapes. An additional weakness of HVOF in comparison with the Hardide process is the need for a binder. A binder weakens the chemical structure making a coating more prone to wear, fatigue and galling. When the binder is worn away tungsten carbide grains stick out of the surface and wear away the component material or seal and HVOF is sometimes referred to as a "cheese grater" for seals. The Hardide coating is free of cobalt and binder, resulting in a stronger, smoother and impervious coating.

The absence of cobalt is also an important factor in nuclear environments where the original cobalt is converted into the radioactive isotope ^{60}Co, which has a half-life of over 5 years and emits gamma rays. It is therefore dangerous.

The Hardide coating is four times more resistant to wear from abrasion than HVOF. HVOF coatings are porous and prone to cracking under high or cyclic load conditions. Therefore, use is restricted where shock loads and impact may cause fracture or failure. A Hardide coating conveys a limited fatigue debit and is not porous.

Binder free, Pore Free Hardide coating



Source: company presentation

One form of HVOF is called Detonation Gun (D-Gun). The delivery mechanism is a long water-cooled barrel with inlet valves for gases and powder. These are then ignited and the resulting detonation projects the material at a velocity that causes it to adhere to the substrate.

Another thermal spray technique is Plasma Spray. This uses a plasma torch that produces an intense electric plasma discharge that ionizes and vaporises the feedstock. This ionised feedstock is then deposited onto the component where it forms a solid coating.

HVOF, Plasma Spray and D-Gun coatings apply hard materials in semi-molten form, building a thick and hard layer, but are line of sight techniques which cannot be applied to internal surfaces and require post-coat grinding, which is extremely difficult on complex geometries.

Corrosion of HVOF and hard chrome compared with Hardide

HVOF after 480 hours

Hard Chrome – had to be removed after 288 hours due to severe corrosion

Hardide after 480 hours

Further tests up to 2000 hours – no corrosion

Source: Hardide.

*****post neutral salt spray to ASTM B117-07a standard***

Hardide Limitations

Although we have pointed out the many ways in which the Hardide process is superior to alternative technologies, there are limitations with the Hardide method. The vacuum chambers in use at present can only accommodate parts that are one metre long or less. Multiple components are loaded into the chamber to gain volume efficiencies. (The ideal component will fit in a shoe box, but components up to one metre long can be coated). Thus, the volume constraint means that a good margin-mix is extremely important to profitability.

The maximum coating temperature is c500ºC. Although technically a limitation, the ability to operate at a low temperature enables important characteristics of the substrate to remain intact. Steel and other metal alloy compositions may be altered at temperatures above 500º C, and can produce undesired consequences. The low temperature enables the choice of a wider range of substrates, thereby allowing clients to use cheaper metals in the design phase. Therefore, although the lower temperature can sometimes be a limitation, a low temperature environment for many substrates is a requirement. Even-lower temperature variants of the Hardide coating are currently in development

Hardide versus Alternative Technologies

Property	HVOF, Plasma, D Gun	Hardide
Corrosion	Porous coating resulting in poor sealing protection	Pore-free coating protects substrate
Fatigue	Potential cracking and spalling under high load and/or high cyclic fatigue conditions	Minimal fatigue debit among hard coatings ranging from -10% to +10%
Application/ Geometries	Line of sight, not suitable for internals or complex shapes	Vapour application allows for complex shapes and internal applications
Finishing	Requires post coat grinding increasing processing length and restricts shapes	No grinding required to achieve good finish
Tribology	Abrasive for counter-body materials. Described as a "Cheese Grater"	Reduces wear of mating parts (metal or elastomer)
	Hard Chrome	**Hardide A**
Wear resistance	Good	Outperforms Hard Chrome by 12x.
Corrosion	Cracking issues prevalent	High resistance to corrosion and Acids
Fatigue	Significant fatigue debit. Typically 20% to 60%	Among hard coatings has minimal fatigue debit ranging from -10% to +10%
Environmental regulation compliance	Restriction by EU REACh (from 21.09.17)	Complies with current regulations;
	PVD coating (TiN, DLC, CrN)	**Hardide**
Application/ Geometries	Line of sight, not suitable for internals or complex shapes	Vapour application allows coating of complex shapes and internal application
Load bearing	Substrate dependent – poor	Less dependent on substrate. Can enable cost reduction because of flexibility in choice of substrate. No binder
Thickness	Typically <5µm	5 to100µm. Typically 50µm.
Corrosion	Porous and so provides limited protection	Pore free coating protects substrate

Source: Company presentations

Key End Markets

Hardide's key end markets are Oil & Gas, Aerospace & Defence, Precision Engineering and Flow Control. Quantifying the size of these addressable end markets is challenging given the niche application of the Hardide product. Therefore, the divisional section below discusses the aggregate size and health of its key markets, the applications which Hardide serve in these markets and further opportunities within each market. Suffice to say, the end market opportunities for Hardide are vast.

By geography Hardide sells into two main markets; the United Kingdom and the North America. Historically, its sales were mainly concentrated in the UK but with the opening of the US facility in 2016, we expect considerable future growth to come from that region. Currently the UK comprises approximately 50% of sales with the majority of the remainder being to North America.

Many industries that require coating of products have in-house coating capabilities. However, outsourcing is becoming more prevalent given the progressively complex needs of clients and the prohibitive capital investment required. Across Hardide's key markets, switching can be slow. This is due to sunk costs, as well as the cost involved in recertification/qualification, as many coated components are safety critical.

New applications are subject to lengthy customer development processes. The applications undergo considerable testing prior to acceptance; the timing of which is beyond Hardide's control. Prior to engaging with a customer on a new application, Hardide assesses the likelihood of the development phase converting into sales and whether the potential commercial opportunity justifies the commitment. In addition, Hardide would expect the customer to commit considerable funding to the process as an indication of its commitment.

The exhibit below gives a brief overview of the end markets, as well as the activity and end applications Hardide addresses.

Addressable End Markets		
End Market	**Activity**	**Components**
Oil & Gas	Production/Directional Drilling Turbo Drilling Completion tools	Pumps for abrasive and corrosive fluids Rotors, stators, drive parts Choke housings, sliding sleeves
Flow control	Pumps and valves	Ball valves, control valves, stem valves, plug valves, triple offset butterfly valves, chock valves, Electric submersible pumps, mud pumps, Centrifugal impellers, housings bearings, Rotors, vanes, shafts, cylinders and sleeve bearings
Aerospace and Defence	Airframe Landing Gear components	Various wing components, pins, bolts Actuators Manifold blocks Helicopter rotor and transmission Components
Precision Engineering	Power Generation Plastic extrusion X-ray anodes Diamond coating	Components for steam turbines and gas compressors Tooling parts Explosives detection and screening Wear parts and cutting tooling

Source: company reports

Oil and Gas

Oil & Gas is the largest sector for Hardide by revenue. Over the last decade, a lack of material traditional oil discoveries, coupled with declining oil reserves has spurred the industry to develop new techniques to allow extraction from increasingly challenging geologies. Extraction of shale oil, tar sand and operation in extremely deep subsea applications are better-enabled by the techniques that have been developed over recent years. These techniques operate under harsh conditions resulting in the need for increasingly sophisticated and durable equipment and components. The costs of these applications are huge and in a post Macondo world, safety is paramount.

After a severe downturn in the Oil & Gas market in 2015, the industry has stabilised and is showing signs of increased activity. The latest Baker Hughes Rig count, which is often used as measure of the health of the Oil & Gas industry, showed the North American rig count for August 2017 to be 425 rigs more than in August 2016. Of greater importance to Hardide is the count for directional drilling which stood at 796 versus 379 in the prior year. Offshore activity is flat versus a year ago, at 17. Given the recent inclement weather in the United States due to hurricanes Harvey and Irma, we expect some lessening of month-on-month activity reported in September. We have assumed any disruption is temporary given the current oil price trajectory and the increasingly tense geopolitical environment that influences the fortunes of the oil industry.

The industry downturn in 2015 resulted in Hardide suffering a substantial decline in revenue. The company was quick to reduce costs in order to protect profitability. Subsequently, Hardide has reported a recovery in O&G sales through 2016 and 1H2017 and we expect this to extend through our forecast period to beyond levels previously achieved.

High levels of commercial sensitivity exist and Hardide is often limited in its ability to announce clients or order specifics. Hardide works with some of the largest players in Oil & Gas including Schlumberger, Halliburton, Weatherford and other major global players where the company is not at liberty to name owing to confidentiality agreements. See the Appendix for testimonials.

Its coatings are used on components where there are high levels of wear, erosion, corrosion, galling and shock loads. It is used for applications which require external and internal surface coatings or on complex shapes where alternative technologies are insufficient. Applications for which Hardide provides coatings are downhole tools, fracking tools, mud-driven hydraulic systems, retrievable packers, frack pumps, stators and impellers, pins, grippers, control valves, actuators and sealing sleeves, to name just a few.

Being harder (1100-1600 Hv), Hardide-T is used typically in oil & gas. Quartz sand, which is the most prevalent abrasive encountered in drilling/fracking, has a hardness of approximately 1000Hv. Therefore the coated component will not be scratched and the seal integrity of the components is not compromised.

Oil and Gas Applications – downhole & fracking tools and completion equipment

Source: company presentations

Flow Control

The flow control market tends to be project-based. Hardide coatings are suitable for metal-seated ball valve applications and are a better-performing replacement for hard chrome coating and Stellite. Ball valves can be exposed to considerable abrasive action from sand and stone chippings in fluids flowing through them and conditions are made worse by acceleration of flow through the valve causing an 'erosive jet'. The Hardide coating is highly resistant to such erosion and corrosion. The binder-free coating also produces a uniform coating and reduces assembly costs. Flowserve is a prominent valve manufacturer that tested Hardide on the balls and seats of stainless steel valves. The Hardide coating remained fully-operational after 70,000 cycles in slurry where Stellite failed at 29,000 cycles.

Hardide coating is also suitable for control valves, diverters, plug valves, triple-offset butterfly valves, choke valves as well as other applications.

The Hardide coating is also very effective in pumps. Similar to ball valves, a typical pump in the oil & gas industry will be handling fluids with quartz or other abrasive materials in suspension, making the pump subject to corrosion and failure, resulting in costly downtime. Hardide was tested in a displacement pump and delivered a four-fold increase in life and significant lengthening of the life of the packing seal. Because of the ability of Hardide to reach internal and external surfaces it is also well suited to coating impellers. Other applications include plungers, rotors, sleeve bearings, cylinders, shafts and housings.

Hardide recently signed a $4m seven-year supply agreement for coatings of products within the Flow control division.

Aerospace and Defence (A&D)

The A&D market is a very big opportunity for Hardide. As discussed above, hard chrome plating (HCP) is used extensively in the industry and is being phased out as part of the EU REACh directive. Hardide management believes there are significant opportunities for Hardide within the A&D industry, not only for its anti-galling properties and as replacement for hard chrome but also as an alternative to HVOF.

Hardide-A closely-replicates the thickness and hardness of hard chrome plating (HCP) so that no dimensional change or redesign of the component is needed when its coating is switched to Hardide. It also conveys better fatigue properties than HCP. The Hardide process results in a compressive stress in the coating, therefore its effect on overall fatigue deficit is modest or even slightly positive (-10% to 10%). Hard chrome has a typical deficit of -20% and can be as high as -60%. Hardide has 12 times the wear resistance of hard chrome, which is also susceptible to micro-cracking. Having effectively zero porosity, Hardide-A has exceptionally good corrosion resistance. Moreover, and as highlighted previously, hard chrome will no longer comply with EU health & safety regulations, which will come largely into effect very shortly.

In 1H17 Hardide received certification as an approved supplier to Airbus for its Hardide-A technology; mainly but not only as an alternative to HCP. The certification is a marked achievement for Hardide after an eight-year process and signals the commercialisation of Hardide-A. It represents a significant inflection point for the company's A&D market opportunity.

Hardide is currently engaged in commercial and technical discussions with Airbus and its supply chain. These are for coatings on its wing structure and hydraulic actuators for landing gear for the A320, A330, A380 and A400M programmes. Its approved supplier status also allows it to provide coatings to Airbus component suppliers and Maintenance and Repair organisations (MROs). We expect discussions to be lengthy and envisage a financial impact in the second half of 2018.

- Hardide received certification as an approved supplier to Airbus and NADCAP accreditation in 2017

Hardide also gained Nadcap accreditation in June of 2017. Nadcap is a global aerospace standard for which the company has been preparing over past three years. It is the top approval in the A&D market and is run by an independent agency for a collective of A&D primes (Airbus, Boeing, Lockheed Martin, Raytheon etc.). This independent agency is the Performance Review Institute (PRI) and it manages the approval and audit system for Nadcap so as to ensure common agreed standards and high quality processes among approved suppliers.

The outlook Aerospace and Defence market backdrop is a good one. Manufacture of civil aircraft is very much driven by the health of the airline industry. Passenger traffic, which is a measure of the airline industry's health, is robust with IATA recording 7.9% global revenue passenger kilometre growth in 1H17 year-on-year. IATA forecasts airline traffic to double over the period 2016 to 2035, growing at 3.7% CAGR. Airline profitability appears to be stable with global capacity being tightly managed after a series of airline mergers, jet fuel prices remaining relatively low and airfare wars limited.

Thus, the civil aviation industry is in good health with high levels of growth, particularly in Asia Pacific, and new fuel-efficient narrow-bodied planes in high demand and attractive financing rates. OEMs currently have c.10 year order books. For example, the Airbus order book the end of 2016 was 6,900 aircraft and A320 production is moving to a staggering 60 per month. Although programme risk exists for the various OEMs, overall the segment is steady and healthy.

The global defence market has entered an upward cycle. The US defence market is the largest and returned to growth with its 2016 budget. In the UK, the strategic defence review has outlined commitments to increase defence spending in the medium term. In addition, NATO nations are under increasing pressure to meet the target of 2% of GDP on defence spending. Increasing geopolitical tensions, globally coupled with underinvestment in program during the last cycle suggest defence will be buoyant for the next c.10 years.

Because of its anti-galling properties, Hardide coating continues to be used on BAE's Typhoon fighter aircraft. Galling, a common phenomenon where metal surfaces sliding against each other when compressed 'tear' their surfaces and this can even lead to 'friction welding'.

Hardide has been working on development programmes with Leonardo Helicopters. The test phase for new helicopter transmission components is progressing well. Longer-term is rotor head components, which is slower because of the limited availability of a highly specialised test rig. Although testing is taking longer, it seems likely that this development will proceed.

Given the time for certification of its processes and the safety critical nature of many of the components Hardide will be treating, we expect increasing sales within A&D to be positive for the group's margin and mix. Given the processes outlined above, the timing of significant volumes is uncertain but our forecasts, in the Financials section below assume that material A&D volumes will occur in 2H18.

Wing Structure and Helicopter Rotor heads

Source: company reports

Precision Engineering

In precision engineering applications Hardide is used where high resistance to wear, corrosion or galling is essential. For example, metal components moving against elastomeric seals, moulds for forming ceramics and plastics as well as powder metallurgy. Hardide's coatings can be used in many industrial applications and therefore its precision engineering clients cover a broad range of industrial applications. The growth forecast for these markets is a reasonable indicator of the economic health of Hardide's clients and therefore give some indication of the potential revenue trends within the precision engineering segment.

Industrial markets are cyclical and driven by the overall economic health of an economy. One of the most-used indicators to track the health of Industrial markets is Industrial production. The forecasts for this in Hardide's two largest markets (UK & US) are broadly positive, but do paint a slightly mixed picture. Trading Economics forecast Industrial production in the UK to rise from 1.7% currently to 2% by 2020 and the US to decline from 2% to 1.1% in 2020.

The IMF's overall economic growth forecasts remain broadly supportive as well. Although revising its figures down slightly in July after a series of upgrades through 2017, the IMF is looking for economic growth in the UK at 1.7% in 2017 and 1.5% in 2018. In the US, the IMF foresees growth at 2.1%, above its long run average, Maurice Obstfeld, the IMF's economic counsellor, was quoted in its June update as saying, "The recovery in global growth that we projected in April is on a firmer footing; there is now no question mark over the world economy's gain in momentum," (The Guardian)

Hardide has been experiencing increasing contract momentum in the precision engineering division. Hardide has recently won a contract for parts on a new high throughput, high resolution airport baggage scanner and explosives detection system now in production. It has also has won approval by Royal Mail for the use of Hardide coatings on components in its sorting machines. Several German OEMs are trialling Hardide to protect tooling and parts of plastic extrusion equipment from wear and chemical attack.

As highlighted earlier in this report, Hardide strives to advance its technology. It has recently developed and patented a coating for industrial diamonds for high precision cutting and abrasive tools. This is a unique development in the advancement of attachment of industrial diamonds to metal. Hardide has on-going trials with several International oil tool producers and has gained orders in the UK.

Competitors

There are a vast number of competitors, both public and private, that comprise the high-performance engineered coatings market. The High-Performance Engineered coatings market is highly fragmented, with Oerlikon as one of the largest players, though having only c.10% market share. As discussed earlier in this report, many large industrial companies have in-house coating facilities and thus skew figures of market share. The aggregate market size has been cited as c. £20bn. The technologies used also vary with some companies providing basic high-volume heat treatment through to those that provide niche products like those of Hardide.

Many of the well-known competitors are divisions of larger Industrial conglomerates such as at Aalberts, Praxair, Oerlikon, Curtis Wright and IHI. Aalberts Industries (AMS: AALB MC: € 4bn) is a Dutch listed conglomerate that provides surface technologies within several of its market segments. Praxair (NYSE: PX MC: $37bn) is a US-listed conglomerate that has a coating division called Surface Technology. Its applications include thermal spray and vapour disposition. Praxair developed the now widely used HVOF process. As part of its thermal spray offering it used both PVD and CVD. Its CVD process uses Titanium nitride and operates at high temperature.

Curtiss Wright (NYSE: CW, MC $4.3bn) is a high tech, critical function product manufacturer and service provider for the industrial, defence and power markets. It has a surface technology division that provides engineered coatings, shot peening and laser peening across its addressable markets. IHI Corp (TYO: 7013 MC ¥574bn) is an industrial conglomerate which provides heat treatment and surface engineering equipment and services across various industrial markets through its Ionbond division. Ionbond uses PVD, CVD, and PACVD technologies to produce for wear resistant and decorative coatings.

Kennamental (NYSE: KMT, MC $2.95bn) designs and manufactures engineered components, advanced materials and tooling for its key markets of aerospace, earthworks, energy, general engineering and transportation. Kennametal provide a wide range of process materials such as tungsten carbide powders and thermal spray powders, as well as thermal treatment and speciality alloy services.

Oerlikon (SWI: OERL MC: CHF 5bn) is an Industrial conglomerate. Its surface solution division specialises in thin-film coating and thermal spray technology. The company has three brands within the division Balzers, Metco and Additives. Balzers specialises in physical vapour disposition (PVD) while Metco supplies spray material and equipment to customers servicing the aviation, power and O&G markets.

As a more pure play, Bodycote (UK: BOY MC: £1.8bn) is a listed UK competitor and mainly provides heat treatment services. It also has a speciality coating business that manufactures various thermal spray and additive products and contribute mid-single digits percentage of overall revenue and applications..

Hardide offers a unique coating technology that is applicable to a very wide range of mechanical devices and components; many of which have yet to be addressed.

In the sections above we have discussed extensively its proven superior characteristics versus that of many other technologies. Its single technology offering is a differentiator, as many of the competitors highlighted above tend to have a portfolio of mainly-mature coating technologies for various applications. Many of those portfolios have been developed through acquisition and we see the Hardide technology as being complementary and sought after by any of the competitors above.

Financials

1H17 Interim results

The 1H17 results on the 16th of May displayed a continued recovery in demand from Oil & Gas clients with sales up 115% in comparison to 1H16. Hardide was approved on a new subsea flow control unit and its onshore drilling and completion components saw good sales momentum. The half delivered tight control of overheads and benefitted from lower levels of capex spend post the delivery of the Virginia facility in 2016.

Hardide delivered Revenue of £1.51m in 1H17 up 59% Y/Y and 27% H/H. Gross profit stood at £0.69m, a gross profit margin of 46%, up from 26% a year ago. The adjusted EBITDA loss declined to (£0.43m) versus (£0.72m) in 1H16. Cash at the end of the period was £1.56m

Features of the period were a contract from GE for $700k for a repeat component order. The contract was unexpected as Hardide thought there were further inventory levels to burn through prior to a follow-on order. The group received Airbus approved supplier status after an eight-year process and is now in discussions with Airbus over commercial terms. Hardide was approved by Royal Mail for coatings on its sorting machines and began receiving orders for machine parts on a new high resolution x-ray baggage scanner and explosive detection system

Estimates

For 2017E we estimate revenue of £3.2m, an adjusted EBITDA loss of £0.7m and an adjusted PBT loss of £1.2m, in line with consensus forecasts. Over the forecast period, which extends to 2020, we estimate positive revenue momentum with £4.1m in 2018E, followed by £5.0m in 2019E and £6.0m in 2020E. The top line momentum is driven by a continued recovery in the Oil & Gas sector, economic growth forecasts being broadly positive (and therefore translating in supportive environment for precision engineering revenues) and, finally, the emergence of material orders in the A&D market resulting from its Airbus and NADCAP accreditations by the end of 2018E.

We estimate an adjusted EBITDA loss of £0.4m in 2018E but see Hardide turning adjusted EBITDA positive in 2019E with £0.1m and £0.7m in 2020E. We have estimated a gross profit margin range of c.53% to 57% across the forecast period.

Central costs increase gradually through the period to account for the loss of grant support for the Virginia facility in 2018 and to reflect slight cost inflation across the group. Therefore, our Adjusted PBT forecasts reflect a loss of £0.9m in 2018E and £0.2m in 2019E, then moving into a slight positive position in 2020E of £0.3m.

We assume a rather large capex outlay in 2018E of £0.7m to increase production capacity to support the revenue projections in 2020. The resulting cash flow projections indicate an increasingly positive operating cash flow position post the outlay of capex in 2018E where FCF is estimate to be a negative £1.1m followed by a flat position in 2019E FCF and £0.4m in 2020E.

Estimates

PROFIT & LOSS	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
Revenue	**2.1**	**3.2**	**4.1**	**5.0**	**6.0**
Adj EBITDA	(1.3)	(0.7)	(0.4)	0.1	0.7
Adj EBIT	**(1.7)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
Reported PBT	(1.5)	(1.2)	(0.9)	(0.2)	0.3
Fully adj PBT	**(1.7)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
NOPAT	(1.7)	(1.2)	(0.9)	(0.2)	0.3
Reported EPS (p)	(0.1)	(0.1)	(0.1)	(0.0)	0.0
Fully adj EPS (p)	**(0.1)**	**(0.1)**	**(0.1)**	**(0.0)**	**0.0**

Source: Progressive Research estimates

Board of Directors

Robert John Goddard – Chairman

Robert Goddard joined the board of Hardide in January 2008 as non-executive Chairman. He also chairs the Risk Committee and the Audit Committee, and is a member of the IP Committee. Before to joining Hardide, Until March 2000 Robert was Corporate Development Director on the board of Burmah Castrol until March 2000. Before this he had managed the Group's worldwide fuels business and a substantial part of its chemical business. In November 2000, he joined Amberley Group plc where he successfully restructured four of its chemical subsidiaries. He currently holds the chairmanship of Universe Group plc. He is an active supporter and investor in several early-stage technology companies.

Philip David Kirkham – Chief Executive Officer

Philip Kirkham was appointed CEO of Hardide in 2012. Philip is a member of the Risk and IP committees. Prior to joining Hardide, Philip was CEO of private equity backed Material Advantage Group which supplies machined metal components into the Oil & Gas industry. Philip has also held senior positions as Firth Rixson Ltd and Rolls-Royce plc. He is a chartered engineer and European Engineer (Eur Ing) and holds a BSc in Chemical Engineering and MSc in Advanced Manufacturing Management. Philip is a fellow of the Institution of Mechanical Engineering and the Institution of Engineering and Technology.

Peter Neil Davenport – Finance Director

Peter Davenport joined Hardide as Financial Controller in June 2005 and was appointed Finance Director in March 2006. He holds a BA in Geography from Oxford University and an MSc in Environmental Science from Oxford Polytechnic and a Certificate in School Business Management. Peter is an associate of the Chartered Institute of Management Accountants. Peter trained as an accountant with the Royal Mail, subsequently working for Parcelforce. He then joined global coatings company Valspar. Peter is a member of the Risk Committee.

Dr Yuri Nikolaevich Zhuk – Technical Director

Dr Zhuk is a co-founder of Hardide plc. Currently Dr Zhuk is responsible for Hardide's technology, R&D, patenting, product improvement and applications development programmes. Dr Zhuk started his career as a scientist later becoming a technology entrepreneur for over 20 years. He holds an MSc (with Distinction) in Physics and a PhD in Plasma Physics and Chemistry from Lomonosov Moscow State University and a MBA from the UK Open University. He is the author of several patents and numerous scientific and technical publications, and frequently presents the Hardide technology at leading international conferences. Yuri chair the IP Committee.

Andrew Richard Boyce – Non-Executive Director

Andrew Boyce joined the board of Hardide in 2012. Andrew represents a family shareholding in Hardide of 17.4% of the groups issued capital. The family have been investors since 2003. Since 1987, Andrew has been involved in the growth and management of family businesses including farming, property and other commercial enterprises. He graduated in 1984 with a degree in Agriculture and Estate Management from the Royal Agricultural College, Cirencester. Andrew worked in Commercial property sales and lettings, development site appraisals and acquisitions. Andrew chairs the Remuneration and Nomination committee and is a member of the Audit Committee.

Janice Elizabeth Ward - Non-Executive Director

Janice Ward joined the board of Hardide plc in March 2015. She is the CEO and co-founder of Corrotherm International, a supplier of specialist metals for critical applications in the Oil & Gas and Aerospace sectors. She has over 30 years of industry experience, 25 at the board level. Jan holds several business appointments and is the winner of many prestigious business awards. She holds a BSc in Mechanical Engineering and is a Fellow if the Institute of Directors and the Royal Society for the Encouragement of Arts, Manufacturing and Commerce. She was named a CBE in 2015 for services to business as well as an honorary Doctorate of Engineering by Southampton Solvent University in 2015. Jan is a member of the Remuneration and Nomination Committee.

Risks

Risks		
Risk	Risk/Impact	Management Action / Comments
Concentration Risk	There is a high concentration of revenue from a few major customers. The loss of one of these would have a material effect on the company's financial performance.	Substantial progress has been made in the developing significant new accounts, thereby broadening the client base. Once adopted and 'designed-in' to a component, it is unusual for Hardide to lose a customer.
Sector Risk	There is a high concentration of revenue from the Oil & Gas Sector. Further oil price shocks or negative effects to the Oil and Gas industry would have a materially negative effect on the company's finances.	The management has been developing new applications and coating variants for a wide range of industries. The recent Airbus certification and Nadcap accreditations, as well as work on X-Ray anodes, etc. provide further evidence of Hardide's expanding end market opportunities.
Development Risk	Customers' test programs can be long (several years), during which Hardide has limited control over the rate of testing. It is a risk that after significant application development time a given test program may not result in sales, or are postponed due to the client's budgetary or other constraints.	Hardide tries to establish early in the development process the likelihood of a development programme converting to sales; as well as assessing whether the potential commercial opportunity justifies Hardide engaging in the development program. Frequently, Hardide can secure development funding by the client.
Employee Risk	Loss of key personnel such as technical staff and key plant staff could result in operational disruptions.	Historically, turnover of key staff is very low and there is a targeted Human Resources strategy to address the long-term recruitment, development and retention of staff.
Economic	Exposure to highly cyclical end markets with limited visibility can result in a sudden adverse revenue 'shock'.	The group has limited control over the cyclical nature of its industrial end markets but has sought to diversify its end market exposure. Additionally, as was in the case of the oil & gas downturn in 2015/2016, it implemented cost savings very early in the downturn to preserve cash and profitability. Conversely the company exhibits high levels of operational gearing during cyclical upturns (investment cycles addressed below). As sales increase, volatility will moderate.

Source: Company reports and Progressive Research

Risks cont'd

Risk	Risk/Impact	Management Action / Comments
Growth/ Investment Risk	Hardide is a high capital expenditure business that is in its growth phase. High levels of investment are required to ensure the company can meet its increasing demand requirements	Hardide is prudent in its expenditure ensuring high levels of capacity utilization and further demand support future investments. In addition, Hardide successfully completed a placing of its shares in 2016, leaving the balance sheet in a position of strength. Shareholders may be called upon in the future to support further growth plans.
Supply disruption	The Hardide process used large quantities of Tungsten Hexafluoride gas in its coating processes, therefore any disruption to feed stock supplies could result in significant production issues.	Hardide has several supply contracts with gas suppliers in Europe. In addition, the UK plant holds buffer stock to mitigate supply risk. The US facility has several suppliers and local production; therefore, the supply risk is relatively low.
Incident Risk	An industrial incident could result in plant shut down or closure.	All operations have been ISO9001/AS9100 and ISO 14001 certified to ensure the highest standards are in practice. Equipment is maintained to a planned schedule, processes of continual improvement are employed and robust health and safety systems and procedures are employed. An additional electricity supply has been installed in the UK site to ensure no supply disruption to the coating reactors. Finally, a business continuity plan has been prepared that includes duality of production capability across the US and UK plants.
Brexit	Effects of Brexit	The effects of Brexit are unknown at this stage. The effect thus far is weak sterling versus other currencies. Versus the USD, Hardide's main exposure, the effect has been beneficial but is subject to reversal. The effect of currency fluctuations has been partially mitigated by the US plant coming on line. Its running costs serve as a natural hedge. Exposure to other currencies is negligible.
M&A	Given the unique nature of the Hardide product, it may be highly attractive to a larger group seeking to complement its coatings/chemical processes portfolio and is thus subject to acquisition risk.	In the event of an approach the board would evaluate an offer and act in the best interest of all shareholders.
Patent Risk	Hardide has patent protection of five 'families' of its technology, which maybe at some point infringed upon as other try to copy its technology.	Hardide holds two patents that protect the compositions, structure and deposition methods of different types of Hardide coatings for metal parts. The patent secures the coatings chemical composition, and this its unique "fingerprint" can be used to rigorously defend its patents. Just as important as patents in protecting its technology is the proprietary knowledge held collectively by Hardide staff.

Source: Company reports and Progressive Research

Summary Financials

Financials

PROFIT & LOSS	FY-15A	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
Revenue	**3.0**	**2.1**	**3.2**	**4.1**	**5.0**	**6.0**
Adj EBITDA	(0.3)	(1.3)	(0.7)	(0.4)	0.1	0.7
Adj EBIT	**(0.5)**	**(1.7)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
Reported PBT	(0.2)	(1.5)	(1.2)	(0.9)	(0.2)	0.3
Fully adj PBT	**(0.5)**	**(1.7)**	**(1.2)**	**(0.9)**	**(0.2)**	**0.3**
NOPAT	(0.5)	(1.7)	(1.2)	(0.9)	(0.2)	0.3
Reported EPS (p)	(0.0)	(0.1)	(0.1)	(0.1)	(0.0)	0.0
Fully adj EPS (p)	**(0.0)**	**(0.1)**	**(0.1)**	**(0.1)**	**(0.0)**	**0.0**
Dividend per share (p)	0.0	0.0	0.0	0.0	0.0	0.0

CASH FLOW & BALANCE SHEET	FY-15A	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
Operating cash flow	(0.2)	(1.4)	(0.7)	(0.4)	0.1	0.6
Free Cash flow (£m)	(1.1)	(1.9)	(0.8)	(1.1)	0.0	0.4
FCF per share (p)	(0.1)	(0.1)	(0.1)	(0.1)	0.0	0.0
Acquisitions	0.0	0.0	0.0	0.0	0.0	0.0
Disposals	0.0	0.0	0.0	0.0	0.0	0.0
Shares issued	0.0	1.6	0.0	0.0	0.0	0.0
Net cash flow	**(1.1)**	**(0.4)**	**(0.8)**	**(1.1)**	**0.0**	**0.4**
Overdrafts / borrowings	0.0	0.0	0.0	0.0	0.0	0.0
Cash & equivalents	2.3	2.0	1.2	0.0	0.0	0.5
Net (Debt)/Cash	**2.3**	**2.0**	**1.2**	**0.0**	**0.0**	**0.5**

NAV AND RETURNS	FY-15A	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
Net asset value	3.9	4.4	3.2	2.4	2.1	2.4
NAV/share (p)	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**
Net Tangible Asset Value	3.8	4.3	3.1	2.3	2.0	2.3
NTAV/share (p)	**0.3**	**0.3**	**0.2**	**0.2**	**0.1**	**0.2**
Average equity	3.9	4.1	3.8	2.8	2.2	2.2
Post-tax ROE (%)	**-3.0%**	**-32.6%**	**-32.4%**	**-30.7%**	**-10.1%**	**13.5%**

METRICS	FY-15A	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
Revenue growth	*-1%*	*-29%*	*50%*	*26%*	*22%*	*20%*
Adj EBITDA growth	*-366%*	*301%*	*-46%*	*-47%*	*-138%*	*388%*
Adj EBIT growth	*-48700%*	*254%*	*-29%*	*-30%*	*-73%*	*-229%*
Adj PBT growth	*642%*	*264%*	*-30%*	*-30%*	*-73%*	*-234%*
Adj EPS growth	*640%*	*211%*	*-24%*	*-30%*	*-73%*	*-234%*
Dividend growth	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
Adj EBIT margins	*-16%*	*-80%*	*-38%*	*-21%*	*-5%*	*5%*

VALUATION	FY-15A	FY-16A	FY-17E	FY-18E	FY-19E	FY-20E
EV/Sales	8.6	12.0	8.0	6.3	5.2	4.3
EV/EBITDA	(79.1)	(19.7)	(36.7)	(69.8)	184.3	37.8
EV/NOPAT	(53.0)	(14.8)	(21.0)	(29.9)	(110.9)	86.1
PER	n.a.	n.a.	n.a.	n.a.	n.a.	88.8
Dividend yield	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FCF yield	-4.6%	-6.6%	-3.0%	-4.2%	0.0%	1.6%

Source: Progressive Research

Appendices

Client testimonials

Company	Application	Testimonial
Weatherford	Bearing Pins for Expandable tools	"The expansion tooling is required to function under a harsh loading environment to expand both slotted and solid base pipe. The rollers are required to function smoothly and effectively over a potentially long, continuous string of expandable sand screen. Therefore the bearing within the rollers must have high strength but low friction capabilities. The Hardide Chemical Vapour Deposition (CVD) coating applied to the roller pins has provided a significant contribution in tool reliability to allow completions to be run in deep wells and also over long production zones of over 2000ft of continuous expandable sand screen."
Flowserve	Metal seated ball valve.	Hardide-coated 316 stainless ball and seats were compared to Stellite ball valve in an abrasive slurry: Stellite failed in 29,000 cycles while the Hardide-coated stainless valve was still in working conditions after 70,000 cycles, tests stopped without valve failure
BAE plc	Aerospace bushes	"Hardide has developed a unique coating technology which addressed a specific challenge being faced on Typhoon. We worked together with Hardide to engineer a solution which was tested extensively and proven successful for the required application. The initial testing and development of the coating, which led to a new Typhoon specification, was successful due to effective communication and the ability of both companies to react accordingly during the testing phase."
EDF Energy	Steam valves in nuclear power plant	"Hardide offered a very cost-effective, high performance solution to extend the life of the 15MW boiler feed pump steam valves in the plant at Hinkley Point B nuclear power plant. There were technical challenges in applying the coating process to the large Stellite 6 valve covers and Hardide provided excellent troubleshooting support and delivered the parts in time so as not to affect the availability of the power plant equipment. Spare valve cover guide sleeves have also been ordered and these will be deployed onto the other unit in the near future. We are also evaluating Hardide for other applications within EDF Energy."
Heap & Partners	Severe service valve	"Hardide has an excellent reputation as a high-performing coating for severe service metal-seated ball valves and seats. We began design and testing of the coating in 2011 and it is now being used on 2" to 4" balls and seats in our new PHASE range of high pressure, side-entry ball valves which are designed for high criticality oil and gas applications."

Source: Company Presentations

Client testimonials cont'd

Company	Application	Testimonial
D Tech Drilling	Drilling applications	“Hardide allows a level of design flexibility that we have not found in other coatings. This means that we can easily revise designs and increase component complexity in the knowledge that Hardide can be applied exactly where we want it.”
Alfred Conhagen, Inc.	Hydrodynamic/hydrostatic radial and thrust bearings	Tested in eight-stage and six-stage high-performance centrifugal pumps in high temperature refinery service. Product temperature of 450oF, when both the octane and diesel have poor lubricity, with entrained solids: pipe scale and some coke fines, and occasionally catalyst carryover which can quickly destroy fine clearances. The Hardide-coated bearings have been in service for three years during which time they have experienced some moderate-to-severe solid ingestion, yet the coated bearing surfaces remain in excellent working condition and were re-used in the refurbished pump. •The substrate is 410 stainless steel to match the coefficient of thermal expansion of the other parts to maintain close clearance over a range of temperatures. With the CVD Tungsten Carbide coating there has been no galling or cracking of the coated surfaces.
Alfred Conhagen, Inc	Pump non-drive end bearing	“For years we have struggled with the design of unique pump components, trying to strike a balance between performance and manufacturability. The Hardide process allows us to finish machine the intricate geometry then add a precise thickness of the Hardide matrix to produce a part with great wear characteristics and low coefficient of friction. Recently, a customer suffered a system upset and introduced a large amount of ceramic bead catalyst to the pumpage and destroyed all of the 8-3stage pump internals except the Hardide-coated components. The Hardide-coated components were re-used in the refurbished pump.”

Source: Company Presentations

Glossary

Chemical Vapour Deposition	(CVD)	A coating process whereby a controlled mix of gases is pumped into a heated furnace creating a coating which crystallises atom-by-atom from chemical reactions of the gases onto the surface of the component, leaving a thin layer of hard coating.
Physical Vapour Deposition	(PVD)	A coating process that evaporates a target material using magnetron sputtering, electric arc or other techniques, and then condenses the vapour on the parts being coated
High Velocity Oxy fuels	(HVOF)	A thermal spray method that mixes oxygen with hydrocarbon gases or liquid fuels, together with a binder material, in a combustible environment
Hard Chrome plating	(HCP)	A coating method whereby an electric current is used to deposit a thin layer of chromium onto a metal object
Detonation gun	(D-GUN)	A method of HVOF where the delivery mechanism is a long water-cooled barrel with inlet valves for gases and powder
Plasma Spray		A method where a plasma torch produces intense an electric plasma discharge that ionizes and vaporises the feedstock. This ionised feedstock is then deposited onto the component where it forms a solid coating.
HDD Addressable Markets		High-performance engineered coatings
Galling		A common phenomenon where metal surfaces moving against each other when compressed and sliding against each other 'tear' their surfaces and this can even lead to 'friction welding'
Fatigue		Fatigue is the weakening of a material caused by repeatedly applied loads. It is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading.

Source: Company Presentations

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