

# Nanoco Group

Sensing the opportunity

Company outlook

With the successful Samsung litigation now in the rear-view mirror, Nanoco's focus will be fully on building the business as a developer, manufacturer and licensor of nanomaterials. With its extensive expertise in quantum dots, validated IP and high-volume manufacturing facilities backed up by a strong balance sheet, we believe that the business has a robust platform for growth. Partnerships with STMicroelectronics and an Asian chemicals supplier position Nanoco strongly to participate in the anticipated adoption of infrared sensors in handsets and a wide range of other devices. If all goes to plan, there could be an inflection in revenues from late FY25 or FY26. We believe the FY24e EV of £15m significantly overlooks Nanoco's commercial potential and the value of its validated IP.

Year end	Revenue* (£m)	EBITDA* (£m)	EPS* (p)	Net cash (£m)	EV/sales (x)	P/E (%)
07/22	2.5	(2.1)	(1.3)	2.8	6.1	N/A
07/23	5.6	(0.5)	(0.7)	3.6	2.7	N/A
07/24e	8.3	0.5	(0.2)	20.0	1.8	N/A
07/25e	10.3	2.2	0.6	17.0	1.5	30.1

Note: \*Revenue, EBITDA and EPS include £6m annual Samsung licence revenue, drawn from deferred income. EBITDA and EPS are normalised, excluding amortisation of acquired intangibles, exceptional items and share-based payments.

## Well placed in a rapid technology adoption cycle

Market analyst Yole expects the short-wave infrared camera market to grow from \$429m in 2021 to \$4.1bn in 2027, driven by adoption in a wide range of lower-volume devices followed by mobile handsets from 2026 and the availability of sensors at significantly lower prices than what is available now. Quantum dots are seen as perhaps the most promising mass market solution, with Yole citing STMicroelectronics and Sony as being best placed to capture share. Success is not guaranteed for Nanoco, but if all goes to plan, we believe that the company could see an inflection in revenues from late in FY25.

## Strong drop through of incremental revenues

We estimate net cash of £20.0m at end FY24, and with good visibility on service sales, the monthly cash burn rate is a modest £0.3–0.4m. With high gross margins, capacity to generate c \$100m revenue without significant further capex and c £30m in tax losses carried forward, incremental revenues should drop strongly through to earnings and cash flow. Even uptake of Nanoco-based sensors in niche applications should be adequate to deliver management's break-even revenue run rate of c £8m. Inclusion in high-volume models would have the potential to generate its FY24e £15m enterprise value (EV) with one year's free cash flows.

## Valuation: Asymmetric risk, skewed to the upside

In our view, Nanoco's EV of £15m undervalues the company's expertise, IP, facilities and customer relationships, as well as its earnings and cash flow potential. Delivery to either our mid- or bull-case scenarios should deliver significant upside. Applying an achievable 10x EV/EBITDA rating to our FY27 mid-case scenario returns a valuation of 46p, and 152p in our bull case. The company's IP, expertise, balance sheet and low-cost run rate should help provide downside protection.

### Tech hardware and equipment

24 June 2024

**Price** **18.19p**

**Market cap** **£35m**

Estimated net cash at FY24 £20.0m

Shares in issue (excluding 13.8m shares held in treasury) 193m

Free float 84.2%

Codes NANO, NNOCF

Primary exchange AIM

Secondary exchange OTC

### Share price performance



%	1m	3m	12m
Abs	(1.5)	(19.2)	(11.6)
Rel (local)	0.5	(22.6)	(19.0)
52-week high/low		23.4p	15.6p

### Business description

Nanoco Group is a global leader in the development and manufacture of cadmium-free quantum dots and other nanomaterials for high-volume use cases. Focus applications are sensors and display.

### Next events

New chairman announcement TBC

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**Nanoco Group is a research client of Edison Investment Research Limited**

## Investment summary

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### **Company description: Nanomaterials platform company**

Nanoco is a global leader in the research, development, licensing and large-scale manufacture of cadmium-free quantum dots and other nanomaterials. The company was founded in 2001 with the specific goal of commercialising quantum dots in high-volume consumer applications and listed (initially on AIM) in May 2009. The company's pathway as a listed business has been circuitous, but the company has established a strong platform consisting of expertise, IP, manufacturing capability and powerful customer relationships. Commercial progress over the past 12 months or so has, in our view, put the business in its strongest position ever to deliver this mass market production goal.

### **Well placed to benefit from mass adoption of infrared sensors**

The immediate opportunity is in the infrared sensing market, where quantum dots can be used to dramatically reduce the cost of sensors, making them applicable for inclusion in high-volume consumer devices. Market analyst Yole expects the short-wave infrared (SWIR) sensor market to grow rapidly, from \$429m in 2021 to \$4.1bn in 2027. This is enabled by the potential for quantum dots to significantly lower sensor costs, with the adoption in mobile handsets driving growth in 2026.

Nanoco looks well placed to play an important role in this structural growth trend. It fulfilled its first commercial order for sensing materials in November 2023. While the company has not disclosed the customer, logic would indicate this is STMicroelectronics (STMicro, STM), a diversified chip supplier, with which Nanoco has been collaborating on infrared sensing materials since at least 2020. STMicro is a leading supplier of sensing chips into the mobile handset and other high-volume markets. It counts Apple and Samsung as customers and has sold over 2bn time of flight sensors, primarily into the handset market.

Looking further ahead, Nanoco has signed joint development agreements (JDAs) to develop second-generation sensing materials with both STMicro and an unnamed Asian chemicals supplier. Management has highlighted that this customer has over 50,000 of its own customers and a particularly strong relationship with the world's largest sensor company. Sony is the world's largest sensor company (with over 200,000 of its own customers), with STMicro number two. Successful development of these second-generation materials should open up new applications for quantum dots, such as automotive, industrial and other applications, with challenging operating environments and where even faster response times are required.

### **Financials: Low cash burn, high operational leverage**

With the final £58.8m tranche from the Samsung settlement received in February 2024, the tender offer now completed and a further £3m worth of shares to be bought back, we estimate Nanoco will have net cash of £20m at end FY24. The company's fixed cash cost base is £7.2m and, through its two JDAs, the company has good visibility on c £1.5m annualised service revenue from H224 to H126.

Incremental revenues should drop strongly through to earnings and cash flows. Gross margins for both materials sales and services are expected to be c 80%. Growth is not likely to require significant capex; Nanoco has a sensor quantum dot manufacturing line able to produce £20m per annum using current shift patterns and £100m worth of quantum dots (likely billions of sensors) per annum without significant further capex. With tax losses carried forward of c £30m, the company is unlikely to pay cash tax in the short to medium term.

## Base-case scenario: Adoption in handsets drives inflection late in FY25

While a range of outcomes are possible, if all goes to plan, we believe that market data is pointing to Nanoco-based infrared sensors being included in high-volume mobile handsets launched in CY26. Working backwards on the assumption of a supply chain taking around nine months from producing quantum dots to devices being shipped, this could drive an inflection in revenues from late in CY25 (H1 of Nanoco's FY26). The best-case scenario would be incorporation of two sensors across a flagship Apple device, which we believe could generate annualised product revenues in excess of £40m. In this case, Nanoco should be generating free cash flow well above the company's FY24e EV of £15m. Reaching break-even would require annual material sales of c £8m (in addition to the existing ongoing JDA revenue), which we estimate could be achieved through shipping 30–40m sensors, depending on the average size and volumes per customer. This could be achieved through incorporation in a small number of models from other manufacturers or in other possible applications for the technology, such as tablets, robotics, control systems, surveillance, VR headsets and wearables. At worst, an obstacle could prevent mass adoption of QD-CMOS technology in any application.

### Exhibit 1: Scenario analysis

£m	FY24e	FY25e	Medium term – c FY27		
			Obstacle prevents mass adoption	1 sensor, lower-volume handsets	2 sensors, tier 1 handset
Reported revenue	8.27	10.30	12.00	24.00	49.00
Underlying (cash) revenue	2.27	4.30	6.00	18.00	43.00
Cash gross profit	1.63	3.57	4.95	14.55	34.55
Cash EBITDA	(5.48)	(3.75)	(2.73)	6.55	26.05
Free cash flow*	23.02	(3.95)	(3.73)	3.33	18.08

Source: Edison Investment Research. Note: Reported revenue includes Samsung licence income of £6m pa, non-cash, drawn from deferred revenue. \*Medium-term scenario factors in a working capital outflow resulting from a significant annual inflection in material sales.

## Valuation: Asymmetric risk skewed to the upside

At a share price of 18.2p, Nanoco's EV is a mere £15m. In our view, this significantly discounts the company's growth, earnings and cash flow potential. Delivery to either our mid- or bull-case scenarios should deliver significant upside. Applying a very achievable 10x EV/EBITDA rating to our mid-case scenario returns a valuation of 46p, more than 100% upside, and 152p in our bull case. Even if the pathway to volume shipments is delayed or hits an obstacle, the company has plenty of financial headroom to assess options and plenty of assets that we believe could be strategically valuable. These include:

- industry leading expertise in a high-growth domain,
- IP – c 370 patents including display IP, which has been validated through the \$150m settlement with Samsung,
- high-volume manufacturing facilities, capable of producing c £100m of sensing materials and enough display materials for around 1 million 65-inch TVs or 80 million smartphones,
- tier one customer relationships with important players in the sensing market, and
- tax losses, of c £30m.

We believe that the key catalysts for the stock include gaining more visibility on Nanoco based sensors being designed into mass market devices and signing up additional JDA partners, with management targeting adding a new partner in display over the next six months.

## Sensitivities: Option value in display, IP, supply chain opacity

**Intellectual property/litigation** – Nanoco's successful process with Samsung has validated the company's IP and management believes that other display companies using cadmium-free quantum dots may also be infringing. The company's preferred approach is to leverage this to forge

commercial relationships, but further litigation is possible. Equally, operating in an IP-heavy field, Nanoco could become subject to litigation from third parties.

**Opaque competitive landscape** – the competitive landscape in quantum dots is opaque, with key competitors either private or part of larger entities. The potential clients of Nanoco and its direct competitors typically do not disclose their architectures or suppliers, at least until products are very close to commercial production. Hence knowledge of Nanoco’s competitive position is limited.

## Taking quantum dots to the mass market

Nanoco is a global leader in the research, development, licensing and large-scale manufacture of cadmium-free quantum dots and other nanomaterials.

### Exhibit 2: Interview with CEO Brian Tenner and CFO Liam Gray

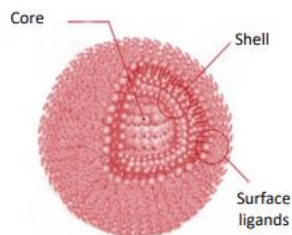


Source: Edison Investment Research

### Quantum dots: An introduction

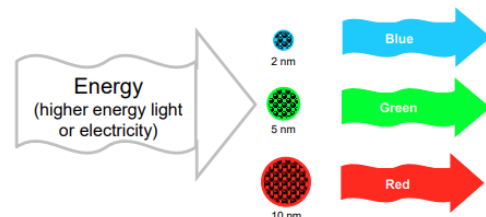
Quantum dots are very small semiconductor particles – with a diameter of 10–100 atoms – that emit different colours of light when energized, typically by light or electricity with a high degree of efficiency. The wavelength (and hence frequency) of the light emitted is dictated by the size of the particle; the smaller the dot, the shorter the wavelength. This makes it possible to produce very pure light (ie with a very narrow band of wavelengths) by energising a solution or material containing quantum dots that are all of a very similar size.

#### Exhibit 3: Tiny semiconductor particles



Source: Nanoco

#### Exhibit 4: Quantum dot size determines colour



Source: Nanoco

These properties make quantum dots applicable across a number of applications, including displays, sensors, bioimaging, biomarking and solar cells, with limited development work currently ongoing outside of sensing and display in order to focus on the most promising short-term commercial opportunities.

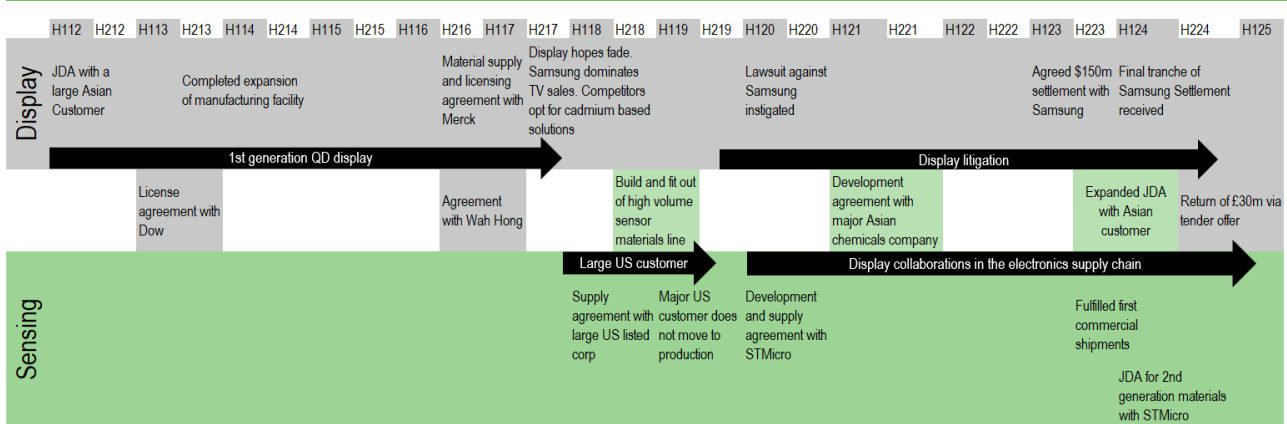
### Focus on high-volume applications

Nanoco's focus is on commercialising quantum dots in high-volume consumer applications. This strategy is underpinned by the company's proprietary 'molecular seeding' manufacturing process, which enables the production of quantum dots to consistently precise dimensions (and therefore colour) without requiring rapid cooling, thus making it a more simple process to scale up. As a consequence, the company's development and commercial activities are centred around the sensors and display, where the commercialisation of quantum dots is most advanced.

### A platform for growth, despite the circuitous pathway

The company's pathway as a listed business has been circuitous, with the initial collaborations across display and sensing failing to develop to commercial production (a milestone that has now been crossed). However, through this process, the company has built up a considerable asset base of expertise, IP, customer relationships, and testing, development and manufacturing facilities, which underpin the company's market position today.

**Exhibit 5: Timeline of development across display and sensing**



Source: Edison Investment Research, Nanoco

### Validated intellectual property

The company has 375 patents in the field of quantum dots and nanomaterials, covering quantum dot chemistry, the manufacture process and applications for their usage. The Samsung litigation and settlement process provided a significant validation of the strength of the company's IP, with the Patent Trial and Appeal Board (PTAB) validating all five patents relating to the process, surviving multiple challenges during the proceedings.

### Scale manufacturing, development and test capability

Nanoco now has the capability and capacity to manufacture materials for low-, medium- and high-volume sensor and display applications at its testing, development and manufacturing facilities in Runcorn UK. The build out of the company's display manufacturing line was self-funded, whereas the sensor manufacturing facility was largely funded by the company's now discontinued engagement with a very large US company. The building and fitout of a wafer device development and test facility is also nearing completion. This should enable Nanoco to significantly accelerate development cycles through applying its nanomaterials to 300mm CMOS semiconductor wafers, (the dominant format for semiconductor chips used in high-volume applications) in house, rather

than sending material to customers for wafer application and awaiting return – a process that could take weeks or months. Management had indicated a capital spend of c £2m in FY24 for the facility fit out and installed equipment. This suggests that the equipment sourced for the facility has been bought at a highly competitive price, with management estimating a new price of ~\$10.0m and stating it was largely sourced from an existing customer.

### **World-class quantum dot expertise**

Nanoco counts 13 PhD holders among its 42 staff and, collectively, its R&D team has over 400 years of experience, built up through its development work with multiple partners over time. Management also emphasises that it has never missed a development milestone with a client, further supporting the business's ability to expand its network of development partners.

### **Recent milestones significantly strengthen prospects**

Nanoco's progress over H1 put the company in its strongest position ever to deliver on its goal of becoming a profitable, cash-generative developer and manufacturer of quantum dots at scale.

**First commercial orders received** – the company announced in November 2023 that it had fulfilled its first commercial order, heralding the company's transition from a development-stage company to a commercial supplier. While initial volumes are low, follow-on orders are expected this calendar year and the client is clearly targeting high-volume applications in the future.

**Expanded development customer base** – the company entered into JDAs to develop a second generation of materials for the near infrared (NIR) and SWIR sensor market, one with STMicro and another with an important chemicals supplier into the electronics industry.

**Device manufacturing facility** – the company's near complete fit out of a wafer device development and test facility should accelerate development cycles and support its initiatives to bring new customers on board. The equipment was provided at a very significantly discounted rate by one of the company's partners, demonstrating clear commitment to the Nanoco relationship and confidence in achieving high-volume sales.

**Team strengthened** – in addition to making hires to support the device manufacturing facility, the company has also added very relevant expertise to its board, hiring Jalal Bagherli (ex Dialog Semiconductor CEO) and Dieter May (ex chairman and CEO of Osram Opto Semiconductors) as non-executive directors.

### **Sensing the opportunity**

The sensing market provides the most significant mid-term revenue opportunity for Nanoco, with the first commercial shipments made and work on JDAs with two significant supply chain partners ongoing.

The CMOS image sensor market is large and growing, with devices being used in a very wide range of applications across mobile handsets, other consumer devices, automotive and industrial automation. Market analyst Yole Group sized the market at \$21.2bn in 2022 and estimates that it will grow to be worth \$30bn by 2030.

The quantum dot sensor market is still in an emergent phase, but quantum dots have a number of specific benefits (see Exhibit 7) that make them a very promising solution across a wide range of applications. In particular, the ability of quantum dots to extend the wavelength of low-cost sensors into the NIR and SWIR spectrum opens up applications such as improved biometric imaging, image enhancement, 3D sensing, night/dark imaging, seeing through smoke or fog and highlighting features or defects that visible imaging cannot. For multifunctional devices, such as



mobile handsets, we believe that the technology's ability to span multiple use cases is likely to be a significant driver of adoption.

**Exhibit 6: IR sensing applications**



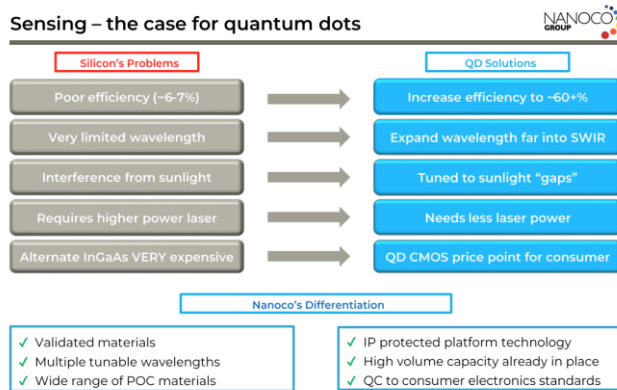
**Huge growing range of high value added applications for NIR / SWIR**

Source: Nanoco

**Quantum dots enabling SWIR sensors at consumer price points**

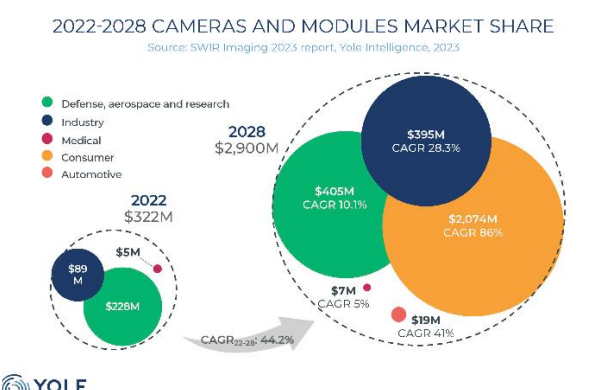
Yole expects the SWIR camera market to grow from \$429m in 2021 to \$4.05bn in FY27, propelled by adoption in consumer devices, principally mobile handsets. This rapid adoption is expected to be enabled by the development of new quantum dot-based architectures, which are expected to dramatically reduce sensor costs versus current compound semiconductor architectures. According to Jonathan Steckel, director of advanced technology intelligence in imaging at STMicro, the cost of its quantum dot SWIR sensor could be down in the single-digit dollar region, similar to what would be paid for a silicon imager. This is significantly more cost-effective than traditional InGaAs SWIR sensors, which can cost hundreds or thousands of dollars.<sup>1</sup>

**Exhibit 7: The benefits of quantum dots in sensors**



Source: Nanoco

**Exhibit 8: SWIR market growth by application**



Source: Yole – SWIR imaging, race for a US\$2bn reward

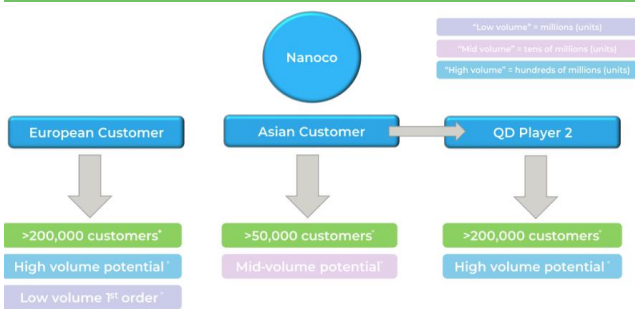
This cost reduction is possible because compound semiconductor architectures require the complete wafer to be made out of expensive, specialist compound semiconductor material (most commonly indium gallium arsenide, InGaAs), whereas in quantum dot designs a thin layer of quantum dots are applied to standard CMOS silicon.

<sup>1</sup> <https://www.imveurope.com/news/sts-quantum-dot-sensor-set-volume-swir-imaging>

## Partners well placed to drive volume sales

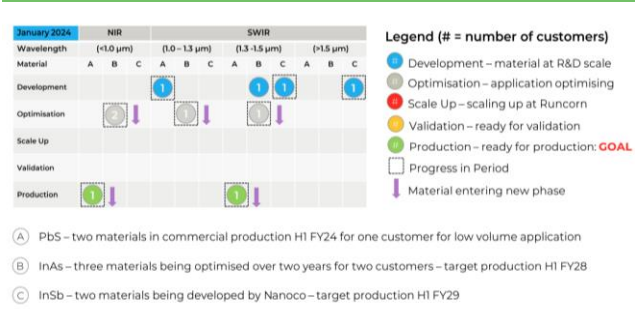
We believe that Nanoco's progress with key partners puts the business in a strong position to play a meaningful role in this major technology upcycle. As a speciality chemicals supplier into the electronics industry, Nanoco operates two or three steps further back in the supply chain to the OEMs. Hence success hinges upon securing design wins with key component suppliers into the high-volume consumer electronics industry, and for these designs to be adopted by major OEMs. While a number of parties are vying for position, Yole has cited STMicro and Sony as two players coming from the consumer imaging industry that have the most potential to disrupt the SWIR sensor market and drive adoption in consumer devices: 'The SWIR industry could emulate the current 3D imaging industry, where STMicro and Sony share nearly 95% of the 225 million shipments (2020 data).' (Yole Group, 'SWIR imagers: STMicroelectronics and Sony could disrupt the technological landscape'.)

**Exhibit 9: Current sensor relationships**



Source: Nanoco

**Exhibit 10: Sensing product pipeline**



Potential mass market mobile phone adoption of SWIR in 2026

Source: Nanoco

## STMicro: Progress with a major supplier of sensors to the mass market

Nanoco first announced a framework agreement with STMicro, covering both development work and commercial supply of nanomaterials for infrared sensing applications, in May 2020. This was followed up in January 2024, when the company announced a new JDA with STMicro to develop a second second-generation sensing material.

STMicro is a leading supplier of sensing chips into the mobile handset and other high-volume markets. It counts Apple and Samsung as customers and has sold over 2bn time of flight sensors, primarily into the handset market. The company has presented details of a quantum dot SWIR image sensor, based on lead sulphide (PbS) quantum dot sensor chips (the same material used in Nanoco's first-generation materials). Through using quantum dots on conventional 300mm silicon wafers, STMicro states that it can produce SWIR sensors at a fraction of the cost of existing technologies (InGaAs compound semiconductors), opening up opportunities in high-volume consumer markets, such as mobile handsets. STMicro indicated that it was expecting to deliver development kits to customers in 2022. Taking into account the commercialisation cycle, which involves testing, optimisation, design into devices, software and key application development, we would expect the first commercial devices to become available within the next 24 months.

Nanoco did not disclose its partner when announcing that it had fulfilled its first commercial order for two of its first-generation sensing materials in November 2023. However, we believe that it is most likely to be STMicro.

It is also worth noting that Nanoco and STMicro originally started working together as part of a supply chain developing sensors for a major US customer during 2018 and 2019. The formal partnership between STMicro and Nanoco was announced in May 2020 shortly after the collaboration with the US customer had been put on the sidelines, giving STMicro the ability to offer such sensor products across its global customer base. STMicro's director of advanced technology



in imaging, Jonathan Steckel, moved to STMicro from Apple in January 2020; at Apple he had been lead technologist in camera core tech & display engineering.

We emphasise that we have no visibility on whether STMicro is still engaged with Apple on developing these products or not. However, STMicro will clearly be targeting Apple and is already a supplier of sensors to Apple, and there are elements of continuity between Nanoco's collaboration with a large US customer and STMicro. So, while bullish, we believe it is relevant to include this scenario in our analysis later in this report.

### **Large Asian chemicals supplier**

In November 2023 Nanoco announced a JDA with an important Asian chemicals supplier (the geographical breakdown in Nanoco's full year accounts suggests this partner is Japanese). This new JDA followed the successful completion of six consecutive proof-of-concept work packages, with the new tranche of work aimed at optimising the company's second-generation nanomaterials for use across a variety of sensing applications. If this JDA is completed successfully, the next stage would be to scale the manufacturing process up to industrial production levels during 2026 and 2027.

Management has highlighted that this customer has a particularly strong relationship with the world's largest sensor company. Sony is the world's largest sensor company (with over 200,000 of its own customers), with STMicro number two.

## **Display: Focus on micro-LED, potential bonus in TV**

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### **Optionality in QD TV and computer displays**

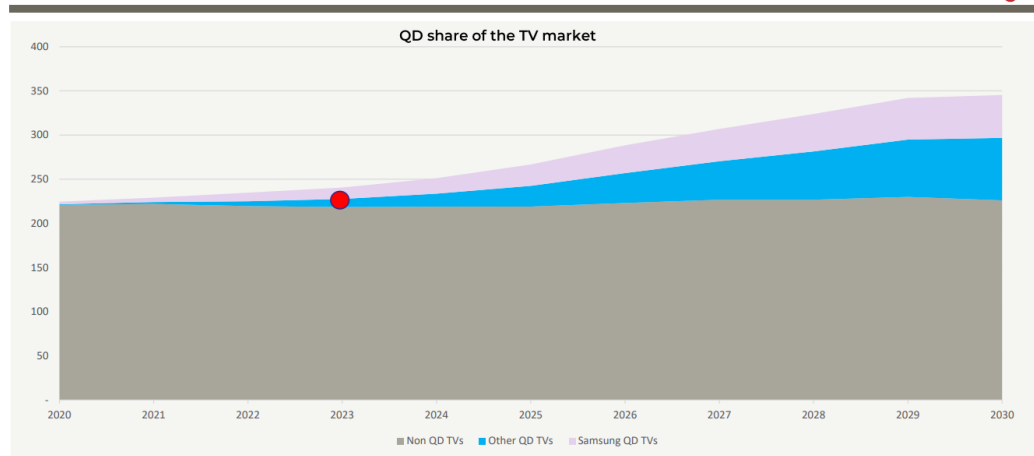
Nanoco's development efforts in display technologies are now focused around the longer-term opportunity in micro-LEDs. However, with the company's IP strongly validated from the Samsung settlement, there may be opportunities to further monetise its IP and manufacturing capability in film-based quantum-dot televisions and computer screens.

Nanoco has production-ready, cadmium-free materials for red and green quantum dots (the current generation of quantum dot displays use the LED backlight to produce blue), and following the successful Samsung outcome, management is reporting increased levels of interest from the display supply chain. The company is also taking its display manufacturing facilities out of 'mothball' to help support these commercialisation initiatives.

Samsung still dominates quantum dot television volumes, but the volumes from other manufacturers are now growing nicely and as they do, so the consequences of IP infringement grow with them. A good proportion of these displays, particularly those targeted towards non-European markets, are likely to use cadmium-based quantum dots. In this case, Nanoco is an obvious supplier for any OEM seeking to sell product based on non-toxic cadmium-free quantum dots.

**Exhibit 11: Quantum dot TV shipments over time**

**2<sup>nd</sup> Fundamental – Valuable Addressable Market**



- Impacted market currently shallow – majority still cadmium
- QD share of display market set to rise from ~6% to ~34% of the total TV market
- Non-Samsung and non-cadmium QD TVs rise from c.2m units to c.70m units
- Potential acceleration in market growth if  $\mu$ LED programmes succeed

Source: Nanoco

**Commercial partnerships the preferred route, but litigation remains an option**

Management’s preferred option is to leverage its IP to forge constructive commercial agreements for either material supply or licensing/royalty arrangements. However, if this route fails then further litigation activity is possible. With the company’s IP validated by the Samsung litigation and a strong balance sheet, the company appears to be holding a robust hand in this regard.

We see this opportunity as a potential bonus rather than being central to the investment case. The current market (for devices using cadmium-free QD solutions) is still low and needs to grow before an attractive IP licensing opportunity develops. As an illustration, the court papers in the Samsung litigation disclosed Samsung’s estimate of the revenue generated by the ‘Dow model’ (ie infringing IP) at around \$6 per TV. Hence, we believe that we would need to see an OEM shipping over one million potentially infringing TVs before this becomes a potential upside event.

**JDA targeted for the emerging micro-LED market**

Micro-LED displays use arrays of microscopic LEDs to form each individual pixel. They are primarily used in small, low-energy devices such as smartwatches, smartphones and VR headsets. Quantum dots can be used to enhance the colour gamut and brightness of the picture in the same way as they do in larger displays.

The micro-LED market has not developed as fast as many expected, but if the technology can continue to be improved and costs brought down, then it should see uptake in high-volume applications. Most major manufacturers are yet to commit to one specific technology path, with OLED and mini-LED also options for small display. As a result, market forecasts vary widely, from 10s to 100s of millions of shipments in the 2028 timeframe, depending on views in terms of which technology will prevail in this timescale.

Nanoco is currently funding the development of materials for micro-LED itself and working with a number of companies on early stage, exploratory engagements. Management is aiming to progress one of these to a paid JDA collaboration within a six-month period and states that this work can be executed by the teams that the business already has in place. The addition of a third line of JDA

work would improve near term revenue visibility and further reduce cash burn. If this work progresses through the development cycle, we estimate that volume shipments could start in 2028 or 2029.

## Competitive environment

Nanoco's competition comes at two levels: from competing quantum dot suppliers and from competing technologies to address the display and sensor markets.

The competitive environment for quantum dots is opaque, in that peers are either privately owned or operations are embedded in much larger businesses. There are also a number of start-ups or university spinouts developing materials for varying applications. However, for the high-volume applications Nanoco is targeting, demonstrating the ability to scale manufacturing will be key to success.

The key players in display are Hansol, Shoei (which acquired Nanosys in 2023) and Samsung (which acquired QD Vision in 2016, possibly to strengthen its IP position).

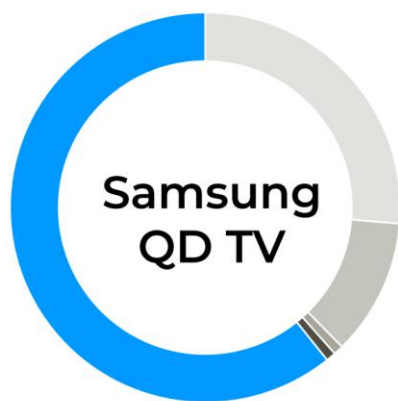
**Hansol** provides captive supply of quantum dots to Samsung and, therefore, we believe is unable to supply quantum dots to competitors to Samsung as relationships currently stand. The litigation process did not conclude on whether Hansol's products infringe Nanoco's IP or not. It also lists sensors as an application, but we have no visibility on commercial progress.

**Shoei** is a Japanese chemicals company, which we believe supplies quantum dots for LG's QD TVs. Shoei acquired Nanosys, Nanoco's most direct competitor, in 2023. Nanosys was the only independent company we know of to achieve commercial shipments, supplying cadmium or 'cadmium light' quantum dots to LG, Sony, Vizio and others.

Exhibit 12 shows the IP fees that Samsung has paid, relating to its quantum dot televisions, with the \$150m settlement to Nanoco accounting for the lion's share of this.

### Exhibit 12: Samsung – IP payouts for quantum dot televisions

#### Competitive IP moat



- Chart shows \$ paid by Samsung for IP for cadmium free QDs in their TVs\*
- Almost two thirds of external payments were to Nanoco
- Opportunity for Nanoco to leverage validated IP for commercial advantage
- Work continues on IP licensing in support of commercial activities
- Retained funds from litigation to support these efforts
- Meaningful results will take time

■ QD Vision ■ Nanosys ■ Samsung ■ Hansol ■ Nanoco

\*Source: published court papers show that Samsung paid \$65m to acquire QD Vision IP portfolio and \$28m to licence Nanosys IP. Hansol as a toll manufacturer assumed not to have much IP. Samsung's own IP not known.

Source: Nanoco

There is much less information available relating to the competitive environment for quantum dots in sensors, particularly not for high-volume mass markets. This may suggest that Nanoco has a lead.

**Hansol** cites sensors as one of the potential applications for its quantum dots, but we cannot find any further information on this initiative.

**SWIR Vision Systems** has launched cameras using quantum dot-based sensors targeted at defence, scientific, automotive and industrial applications. SWIR's focus appears to be on high-end specialist cameras and sensors and we cannot see any evidence of it targeting the very high-volume markets served by STMicro and Sony. SWIR is now part of the Teledyne group of companies and US based.

**Emberion** is a privately held Finnish company. It has launched thermal imagers using proprietary quantum dot technology. Again we cannot see any evidence of it targeting high-volume consumer markets.

## Financials

### Long- to medium-term opportunity key to value creation

We focus our narrative on Nanoco's medium- to longer-term model, as Nanoco's investment case hinges on the potential for the business to generate significant growth, earnings and cash flows in this timeframe. The timing and quantum of any inflection is still difficult to gauge, being dependent on the launch and success of products that are yet to be revealed.

However, we believe that the indicators discussed throughout this report point towards a central 'if all goes to plan' scenario of Nanoco-based infrared sensors being included in high-volume mobile handsets launched in CY26. Taking into account supply chain lead times, this could drive an inflection late in Nanoco's FY25.

Even within this scenario, the range of possible outcomes is large. To illustrate, we present three possible scenarios in Exhibit 13, examining the potential for revenues, EBITDA and free cash flow in a medium term (c FY27) timeframe.

These scenarios reflect the expectation that incremental revenues drop strongly through to earnings and cash flows. The company's fixed cash cost base is £7.2m and through its two JDAs, the company has good visibility on c £1.5m of annualised service revenue from the second half of FY24 to the first half of FY26. Gross margins for both materials sales and services are expected to be c 80%, so while some investment in working capital will be required, the low cost of goods sold will mean that inventory demands are modest. Growth is not likely to demand significant capex; Nanoco has a sensor quantum dot manufacturing line able to produce £20m worth of sensor quantum dots in Runcorn with current shift patterns and £100m with increased shifts but little additional capex. With tax losses carried forward of c £30m, the company is unlikely to pay cash tax in the short to medium term.

<b>Exhibit 13: Scenario analysis</b>					
£m	FY24e	FY25e	Medium-term (c FY27e) scenarios		
			Obstacle prevents mass adoption	1 sensor, lower volume handsets	2 sensors, tier 1 handset
Volumes			<20m	50–100m	>200m
Material sales	0.87	1.80	3.00	15.00	40.00
Services	1.40	2.50	3.00	3.00	3.00
<b>Core revenue</b>	<b>2.27</b>	<b>4.30</b>	<b>6.00</b>	<b>18.00</b>	<b>43.00</b>
Samsung licences (non cash)	6.00	6.00	6.00	6.00	6.00
Total revenue	8.27	10.30	12.00	24.00	49.00
Cash gross margin					
Material sales	72%	80%	80%	80%	80%
Services	72%	85%	85%	85%	85%
Samsung licences (non cash)	0%	0%	0%	0%	0%
Gross profit					
Material sales	0.62	1.44	2.40	12.00	32.00
Services	1.01	2.13	2.55	2.55	2.55
Cash gross profit	1.63	3.57	4.95	14.55	34.55
Reported gross profit	7.63	9.57	10.95	20.55	40.55
Cash operating expenses	(7.12)	(7.32)	(7.63)	(8.00)	(8.50)
<b>Cash EBITDA</b>	<b>(5.48)</b>	<b>(3.75)</b>	<b>(2.68)</b>	<b>6.55</b>	<b>26.05</b>
Reported EBITDA	0.52	2.25	3.32	12.55	32.05
Working capital	1.08	0.48	0.90	2.70	6.45
As % of sales	0.48	0.11	0.15	0.15	0.15
Change in working capital	30.58	0.60	(0.42)	(2.22)	(5.97)
Capex	(2.08)	(0.50)	(0.58)	(1.00)	(2.00)
Tax	0.00	(0.30)	0.00	0.00	0.00
<b>Free cash flow</b>	<b>23.02</b>	<b>(3.95)</b>	<b>(3.68)</b>	<b>3.33</b>	<b>18.08</b>

Source: Edison Investment Research



A best-case scenario possible for the c FY27 timeframe would be incorporation of two sensors (one front and one rear-facing) across a flagship Apple device. Individual Apple devices sell in significantly higher volumes than those of any other vendors. (While this bullish scenario is only one out of many potential outcomes, given the previous and current partnerships of both Nanoco and STMicro, we feel it is relevant to include it.) This could generate annualised product revenues in excess of £40m. In this case, Nanoco should be generating free cash flow well above the company's FY24e EV of £15m.

Reaching break-even would require material sales of c £8m or in the region of 35m sensors annualised. This could be achieved through incorporation in a small number of flagship models from other manufacturers or in other possible applications for the technology, such as tablets, robotics, control systems, surveillance, VR headsets and wearables.

At worst, an obstacle could significantly suppress, delay or prevent mass adoption entirely. However, with a strong balance sheet, a modest cost base and the ability to generate service revenues, Nanoco would have ample headroom to examine other routes for maximising shareholder value.

## Near-term forecasts and estimate changes

Nanoco's interims results contained no surprise, although gaining a look through to Nanoco's underlying performance is somewhat obscured by the treatment of the Samsung proceeds. Revenues grew from £1.6m in H123 to £4.0m in H124, which was driven by the draw down of IP licence income, which has been pre-paid by Samsung and drawn down from deferred income. Licence revenues will continue to be drawn down from deferred revenues (£46.5m at H123) at a rate of c £6m per annum until H130.

Underlying revenue (excluding Samsung licence revenue) decreased to £1.0m from £1.6m, primarily reflecting the timing of the STMicro agreement being signed towards the end of the period. The second phase of work with STMicro has now started. FY25 should benefit from a full year contribution from the two sensor JDAs, with our forecasts factoring in the expectation of adding a third JDA partner.

While the company fulfilled its first commercial order during the period, this was for low volumes and hence revenues from material sales remained modest at £0.3m (£0.4m in H123). We believe that material sales are likely to remain relatively modest until volume commercial shipments of Nanoco-based devices commence, with late FY25 being our base case estimate for the timing of this.

<b>Exhibit 14: Revenue model (£m)</b>					
	<b>FY22</b>	<b>FY23</b>	<b>FY24e</b>	<b>FY25e</b>	<b>Comment</b>
Products sold/material sales	0.8	0.9	0.9	1.8	Production and development material shipments
Services	1.6	1.7	1.4	2.5	Paid services under joint development agreements and other smaller projects
Royalties/licences	0.1	3.1	6.0	6.0	Recognition of Samsung settlement. Drawn down from deferred revenue.
<b>Total</b>	<b>2.5</b>	<b>5.6</b>	<b>8.3</b>	<b>10.3</b>	

Source: Nanoco data, Edison Investment Research estimates

Factoring in some reinvestment back into the business, cash operating costs are running at c £0.6m per month, while we factor in capex of £2m for FY24 to reflect the investment in the wafer device facility. Maintenance capex levels are expected to be c £0.5m, with underlying net monthly cash burn expected to be a modest £0.3–0.4m.

With the final £58.8m tranche from the Samsung settlement received and assuming full participation in the £33m tender offer and buy back, we estimate Nanoco will have net cash of £20m at end FY24, with all debt paid off.

### Minor estimate changes

We have implemented minor changes to our estimates. Our FY24 revenue estimate reduces slightly to reflect the later than anticipated signing of JDAs, leaving less work to complete this year, which is also reflected in EBITDA. Our year-end net cash increases by £1.5m primarily because we had previously modelled a £36m cash return (via dividend).

Exhibit 15: Estimate changes						
Year end 31 July	FY23	FY24e				FY25e
£m	Actual	Old	New	Change	y-o-y (%)	New
Revenues	5.6	8.6	8.3	-3.3%	47.2%	10.3
Gross profit	4.8	7.7	7.6	-0.9%	60.0%	9.6
Gross margin	84.9%	90.1%	92.3%			92.9%
EBITDA	(0.5)	1.3	0.5	-60.6%	-207.3%	2.2
Reported operating profit	15.0	(0.7)	1.1	-273.8%	-92.4%	0.4
Reported operating margin	267%	-8%	14%			4%
Normalised net income	(2.1)	(0.4)	(0.7)	62.7%	-67.7%	1.7
Normalised diluted EPS (p)	(0.66)	(0.13)	(0.25)	89.8%	-62.6%	0.60
Net debt/(cash)	(3.6)	(18.5)	(20.0)	8.0%	447.9%	(17.0)
Cash	8.2	18.5	20.0			17.0
Debt	(4.6)	0.0	0.0			0.0

Source: Nanoco data, Edison Investment Research

## Valuation: Risk reward looks asymmetric

Nanoco's share price of 18.2p implies an FY24e EV of a mere £15m, assuming full participation in the tender offer and buyback. In our view, this completely discounts the company's growth, earnings and cash flow potential, implying an expectation that the business will not reach an inflection point in growth, earnings and cash flow. Delivery to either our mid- or bull-case scenarios should deliver significant upside.

While Nanoco's less mature revenue profile and lack of direct peers mean that a formal peer analysis could be misleading, the valuation of UK-listed hardware businesses is currently averaging around 10x EV/EBITDA on a two-year forward view. Given Nanoco's likely strong conversion of cash EBITDA, we believe that such a rating would be easily justifiable, once the pathway to volume shipments becomes clearer (while adjusting to exclude the £6m of Samsung licence revenue from our figures). A 10x EV/EBITDA rating on our mid-case scenario returns a valuation of 46p, more than 100% upside, and 152p in our bull case.

Exhibit 16: Valuation metrics under key scenarios					
	2024e	2025e	Bear	Mid	Bull
EV/underlying sales (x)*	6.0	3.2	2.3	0.8	0.3
EV/cash EBITDA (x)*	loss	loss	loss	2.1	0.5

Source: Edison Investment Research. Note: \*Underlying sales and EBITDA exclude £6m pa Samsung licence income, drawn from deferred revenue.

Even if the pathway to volume shipments is delayed or hits an obstacle, the company has plenty of financial headroom to assess options and plenty of assets that we believe could be strategically valuable. These include:

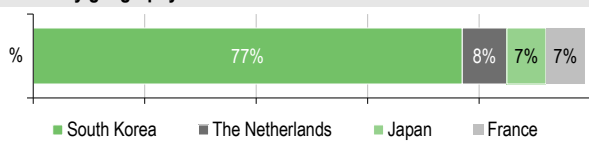
- industry leading expertise in a high-growth domain,
- IP – c 350 patents including display IP, which has been validated through the \$150m settlement with Samsung. Samsung also paid \$65m for QDVision's quantum dot patent portfolio,
- high-volume manufacturing facilities, capable of producing c \$100m of sensing materials and enough display materials for around one million 65-inch TVs or 80 million smartphones,
- tier one customer relationships with important players in the sensing market, and
- tax losses, of c £30m.

We believe that the key catalysts for the stock include gaining more visibility on uptake of Nanoco-based sensors in mass market devices and signing up additional JDA partners, with management targeting adding a new partner in display over the next six months.

**Exhibit 17: Financial summary**

	£m	2022	2023	2024e	2025e
Year end 31 July		IFRS	IFRS	IFRS	IFRS
<b>INCOME STATEMENT</b>					
Revenue		2.5	5.6	8.3	10.3
Cost of Sales		(0.9)	(0.8)	(0.6)	(0.7)
Gross Profit		1.5	4.8	7.6	9.6
EBITDA		(2.1)	(0.5)	0.5	2.2
Operating profit (before amort. and excepts.)		(4.2)	(2.9)	(0.4)	1.3
Amortisation of acquired intangibles		0.0	0.0	0.0	0.0
Exceptionals		0.0	18.9	2.5	0.0
Share-based payments		(0.6)	(1.0)	(1.0)	(1.0)
Reported operating profit		(4.8)	15.0	1.1	0.4
Net Interest		(0.5)	(0.7)	0.2	0.7
Exceptionals		0.0	(4.7)	0.0	0.0
Profit Before Tax (norm)		(4.6)	(3.6)	(0.2)	2.0
Profit Before Tax (reported)		(5.2)	9.6	1.3	1.1
Reported tax		0.5	1.5	(0.5)	(0.3)
Profit After Tax (norm)		(4.1)	(2.1)	(0.7)	1.7
Profit After Tax (reported)		(4.7)	11.1	0.8	0.8
Minority interests		0.0	0.0	0.0	0.0
Net income (normalised)		(4.1)	(2.1)	(0.7)	1.7
Net income (reported)		(4.7)	11.1	0.8	0.8
Average Number of Shares Outstanding (m)		308	322	278	290
EPS - normalised (p)		(1.32)	(0.66)	(0.25)	0.60
EPS - normalised fully diluted (p)		(1.32)	(0.66)	(0.25)	0.60
EPS - basic reported (p)		(1.52)	3.44	0.30	0.27
Dividend per share (p)		0.00	0.00	0.00	0.00
<b>BALANCE SHEET</b>					
Fixed Assets		1.8	7.7	8.6	8.0
Intangible Assets		1.6	1.0	0.8	0.6
Tangible Assets		0.2	2.4	3.5	3.1
Deferred income		0.0	4.3	4.3	4.3
Other		0.0	1.8	1.8	1.8
Current Assets		9.0	43.1	23.3	20.1
Stocks		0.2	0.3	0.7	0.7
Debtors		1.5	34.0	2.0	1.8
Cash & cash equivalents		6.8	8.2	20.0	17.0
Other (including proceeds from settlement receivable in FY24)		0.5	0.6	0.6	0.6
Current Liabilities		(2.4)	(14.0)	(9.0)	(9.4)
Creditors		(1.5)	(2.6)	(1.6)	(2.0)
Tax and social security		0.0	(0.8)	(0.8)	(0.8)
Short term financial leases		(0.2)	(0.5)	(0.5)	(0.5)
Short term bank debt		0.0	(4.0)	0.0	0.0
Other (including deferred licence income)		(0.7)	(6.1)	(6.1)	(6.1)
Long Term Liabilities		(4.0)	(20.2)	(38.6)	(32.6)
Long term financial leases		(0.0)	(1.4)	(0.7)	(0.7)
Loan notes		(3.9)	(0.6)	0.0	0.0
Other (including deferred licence income)		(0.1)	(18.2)	(38.0)	(32.0)
Net Assets		4.3	16.6	(15.7)	(13.9)
Minority interests		0.0	0.0	0.0	0.0
Shareholders' equity		4.3	16.6	(15.7)	(13.9)
<b>CASH FLOW</b>					
Operating Cash Flow		(2.3)	(0.4)	0.5	2.2
Working capital		0.1	24.5	50.3	(5.4)
Exceptional & other		(0.2)	(47.5)	2.5	0.0
Tax		0.7	(4.2)	0.0	(0.3)
Net Operating Cash Flow		(1.8)	(27.6)	53.3	(3.5)
Capex		(0.1)	(0.4)	(2.1)	(0.5)
Net proceeds from Samsung settlement		0.0	34.5	0.0	0.0
Net interest		(0.0)	(4.7)	0.4	0.9
Equity financing		5.4	0.0	(34.5)	0.0
Dividends		0.0	0.0	0.0	0.0
Other		(0.6)	(0.5)	0.0	0.0
Net Cash Flow		2.9	1.3	17.1	(3.0)
Opening net debt/(cash)		(0.3)	(2.8)	(3.6)	(20.0)
FX		0.0	0.2	0.0	0.0
Other non-cash movements		(0.4)	(0.6)	(0.8)	0.0
Closing net debt/(cash)		(2.8)	(3.6)	(20.0)	(17.0)

Source: Nanoco Group accounts, Edison Investment Research

<p><b>Contact details</b></p> <p>Science Centre The Heath Business &amp; Technical Park Runcom WA7 4QX United Kingdom +44 (0) 1928 761422 www.nanocotechnologies.com</p>	<p><b>Revenue by geography</b></p>  <table border="1"> <thead> <tr> <th>Geography</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>South Korea</td> <td>77%</td> </tr> <tr> <td>The Netherlands</td> <td>8%</td> </tr> <tr> <td>Japan</td> <td>7%</td> </tr> <tr> <td>France</td> <td>7%</td> </tr> </tbody> </table>	Geography	Percentage	South Korea	77%	The Netherlands	8%	Japan	7%	France	7%
Geography	Percentage										
South Korea	77%										
The Netherlands	8%										
Japan	7%										
France	7%										
<p><b>Management team</b></p>											
<p><b>CEO: Brian Tenner</b></p> <p>Appointed in September 2020, Brian previously served as the company's COO, CFO and secretary. He has held senior finance positions in a number of multinational companies, including interim CEO and CFO at NCC Group, and CFO at Reynold, Scapa and British Nuclear Group. He is a chartered accountant (PwC) and holds a law degree from Edinburgh University.</p>	<p><b>CFO: Liam Gray</b></p> <p>Appointed in November 2021, Liam previously served as Nanoco's UK finance director and company secretary since September 2020, having joined the company in March 2019 in the role of group financial controller. He has held a number of senior finance roles in both public and private companies, having started his career with KPMG and qualified as a chartered accountant. He holds a degree in accountancy from the University of Liverpool.</p>										
<p><b>Chairman: Dr Christopher Richards</b></p> <p>Dr Christopher Richards has been chairman since May 2016 and joined the board in November 2015. He was formerly chief executive and non-executive chairman of Arysta LifeScience and holds a number of executive and non-executive roles. He is due to retire from the board following the next AGM.</p>	<p><b>CTO: Dr Nigel Pickett</b></p> <p>Dr Nigel Pickett was co-founder of Nanoco and inventor of its quantum dot scale-up technology. He has co-authored over 70 academic papers, is an inventor on 150 patents and pending patents. He has a passion and experience in taking research work from the academic bench through to full commercialisation.</p>										
<p><b>Principal shareholders</b></p>											
<p>Hargreaves Lansdowne stockbrokers</p> <p>Lombard Odier Investment Managers</p> <p>Interactive Investor</p> <p>Tariq Hamoodi</p> <p>Dr Nigel Pickett</p> <p>Barclays Smart Investor</p> <p>Oryx International</p>	<p>16.38%</p> <p>14.57%</p> <p>9.05%</p> <p>4.05%</p> <p>3.63%</p> <p>3.35%</p> <p>3.03%</p>										



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