IQE

Interims and strategy update

Photonics driving second growth wave

Tech hardware & equipment

Towards the end of H117 one of the numerous development programmes for photonics applications that IQE has been working on moved to volume production. The programme, which we infer relates to 3D sensing in the iPhone X, potentially has a transformational impact on IQE's performance. Until there is clarity on the rate of roll-out of the new phone however, our estimates, which are unchanged from the trading update in July, model a cautious ramp-up in IQE's epitaxy sales. The share price is looking for performance substantially ahead of this, which our scenario analysis suggests is achievable. Importantly, even if demand for the iPhone X is muted, IQE is engaged in multiple photonics development programmes with the potential to generate transformational levels of growth.

Year end	Revenue (£m)	PBT* (£m)	EPS* (p)	DPS (p)	P/E (x)	Yield (%)
12/15	114.0	17.6	2.60	0.0	50.4	N/A
12/16	132.7	20.6	3.00	0.0	43.7	N/A
12/17e	145.3	23.5	3.26	0.0	40.2	N/A
12/18e	160.3	25.9	3.57	0.0	36.7	N/A

Note: *PBT and EPS are normalised, excluding amortisation of acquired intangibles, exceptional items and share-based payments.

Photonics underpins H117 growth

The strong photonics growth noted since FY14 continued into H117. A 48% leap in photonics revenues and a 10% currency tailwind delivered a 12% y-o-y increase in group revenues during H117 to £70.4m. Adjusted operating profit from the wafer manufacturing operations grew by 32% to £9.6m. However, this was offset by a reduction in licence fees, which benefited from one-off upfront payments in H116, resulting in small (2%) decrease in group adjusted operating profit to £10.6m.

Multiple growth drivers beyond VCSELs

Importantly, part of the H117 growth is attributable to the onset of volume deliveries of VCSEL epitaxy for the iPhone X. This is in addition to continued work on a range of programmes that also have potential to become volume contracts in future. This includes VCSELs for other consumer applications such as hand and body tracking, automotive applications, data comms and industrial applications such as heating; InP (indium phosphide) wafers for high-speed data networks and GaN (gallium nitride) wafers for radio frequency and power applications. This range of applications gives potential for growth without the reliance on the handset market that has bedevilled IQE in the past.

Valuation: Some earnings upgrades already priced in

IQE shares are trading on an FY18e P/E multiple of 36.7x which, compared to the average for our broader sample of peers (16.8x), implies an EPS of 8.8p. Our analysis (see Exhibit 5 on page 12) of the impact of a potentially faster VCSEL volume roll-out than that modelled in our current estimates indicates that this earnings run rate is achievable.

18 September 2017

Price	**131.00p**
Market cap	**£900m**

Net debt (£m) at end June 2017	41.9
Shares in issue	685.9m
Free float	88.5%
Code	IQE
Primary exchange	AIM
Secondary exchange	N/A

Share price performance

%	1m	3m	12m
Abs	(2.9)	86.3	389.8
Rel (local)	(2.2)	90.6	346.1
52-week high/low		157.25p	29.00p

Business description

IQE is the leading supplier of epitaxial compound semiconductor wafers globally. The principal applications include radio frequency semiconductors, devices for optical networks, vertical cavity lasers, infrared semiconductors, power electronics and CPV solar cells.

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Prelims	March 2018

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Investment summary

Wide product offer addresses multiple verticals

IQE is the largest supplier of compound semiconductor epitaxy wafers globally and has the most comprehensive product offering. This extensive technology range has helped it to gain more than a 50% share of the wireless market, and a significant majority of sales (67% in H117) are still generated from this segment, where its wafers are used to make radio frequency chips, primarily for use in mobile devices. As smartphone growth has slowed, profits have been invested in developing technologies addressing other industry verticals with the potential to drive strong growth over a five- or six-year period. Most immediately, revenues from the photonics segment (23% of H117 revenues) are growing strongly, heralding the start of a mass-market ramp up in VCSEL (vertical cavity surface emitting laser) wafers for consumer applications. Revenues from the supply of epitaxy for higher power applications represent potential for a third wave of growth in future years.

Financials: Management adding capacity for strong growth

Our estimates assume modest growth in wireless revenues, backed by market share gains and deployment in new applications such as base stations (in partnership with MACOM). We assume that photonics revenues will continue to grow strongly, driven by ramp-up of the multiple, multi-year VCSEL epitaxy contracts, which we infer are for the iPhone X, and by numerous programmes at different stages of development. We note the potential for stronger growth during the forecast period if volume ramp-up for the iPhone X is faster than assumed in our model or if other VCSEL programmes also pass into volume production. (Consensus estimates look for £163.6m sales in FY18 generating 3.8p EPS, compared with our £160.3m and 3.6p.) Noting that H218 demand was likely to be higher than it had initially anticipated, in July 2017 management announced a capacity expansion plan sufficient to support an estimated £250m of annual revenues by FY19. This is significantly higher than the growth trajectory assumed in our estimates. While this capacity is believed to be primarily intended to support iPhone X-related contracts, it could be used to fulfil volume orders for other programmes once they reach the commercialisation phase.

Valuation: Price anticipates further upgrades

The share price has trebled since the interims in March as investors have speculated on the potential impact of volume VCSEL programmes on earnings. As a result, the share price already discounts substantial upgrades. On page 12, we present a detailed scenario analysis considering the impact of a faster ramp up in VCSEL volumes on earnings and profit related multiples and thus the scale of potential upgrades that may be achieved.

Sensitivities: Uncertainty in predicting rate of volume ramp-up

The key sensitivity at present is the rate of growth of the current volume VCSEL programmes for the iPhone X, which are not under IQE's control, and the onset of volume deliveries for other VCSEL programmes and newer technologies such as InP nanoimprint lithography and GaN-on-Si. While the growth in photonics has substantially diversified the business, IQE's financial performance remains heavily influenced by the health and inventory cycle of the handset industry. Sales and earnings are also exposed to changes in the US dollar/sterling exchange rate. The impact is largely translational, with minimal transactional exposure.

Company description: Leading epitaxial wafer supplier

IQE is the largest outsourced supplier of compound semiconductor epitaxy wafers globally. It has the most comprehensive product offer, which encompasses over 100 patents and a rich pool of trade secrets. IQE takes very thin discs of compound semiconductor material up to 150mm in diameter (wafers) and deposits successive thin “epitaxial” layers, each containing different combinations of semiconductors on them. These epitaxy wafers are used by manufacturers of wireless chips and optical devices such as laser chips, which carry out further processing steps to create finished devices. IQE has reached its dominant position with respect to both market share and breadth of product offer through a combination of organic development and acquisitions. It has facilities in Europe, the US and Asia, giving it a presence in all three major semiconductor manufacturing regions and the ability to provide a second source of supply for customers.

Over the last decade, the majority of IQE’s revenues have been derived from the wireless market. At 67% of H117 revenues, this is still the case. However, enhancements to the technology are driving strong growth in the photonics sector and taking IQE into new application areas such as touchless sensing, gesture recognition, non-invasive blood monitoring and power electronics. Noting the numerous development programmes for photonics applications related to data communications, automobiles, industrial heating and gaming, we expect the proportion of revenues from non-wireless applications to continue to increase and for exposure to the handset market to decrease as some of these programmes pass into volume production. We also expect IP licensing to form a significant proportion of revenues in the longer term.

IQE employs around 500 people and its headquarters are in Cardiff, Wales. The shares were admitted to the London Stock Exchange in 2000.

Technology overview

Broad IP portfolio addresses multiple industry verticals

Exhibit 1: Key properties of compound semiconductors by application

Reporting segment	Wireless			Photonics					Advanced materials
Property/ application	**Mobile RF**	**RF infrastructure**	**M2M comms**	**Solar power (CPV)**	**Optoelectro-nics/VCSEL**	**Power electronics**	**Lighting**	**Thermal/ IR sensors**	
Higher operating speeds	✓✓	✓✓✓	✓		✓✓✓	✓✓			✓✓✓
Lower power consumption	✓✓✓	✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓		✓✓
Reduced noise and distortion	✓✓✓	✓✓✓	✓✓		✓✓✓				✓✓
Light-emitting and detecting properties		✓✓✓✓		✓✓✓✓	✓✓✓✓		✓✓✓✓	✓✓✓✓	✓✓
Incumbent technology	GaAs SOI	GaN	N/A	Silicon	GaAs, InGaP	Silicon	Non-LED-CFL, incandescent LED – SiC, Sapphire	Antimonides	Various, but predominantly silicon
Emerging technologies	Silicon/ silicon on insulator InGaP	GaN	Various (depending on requirements)	CPV solar (multiple layers of different compounds)	GaN	GaN-on-Si GaN-on-SiC	GaN on silicon	Antimonides	GaN, GaAs, various others depending on application

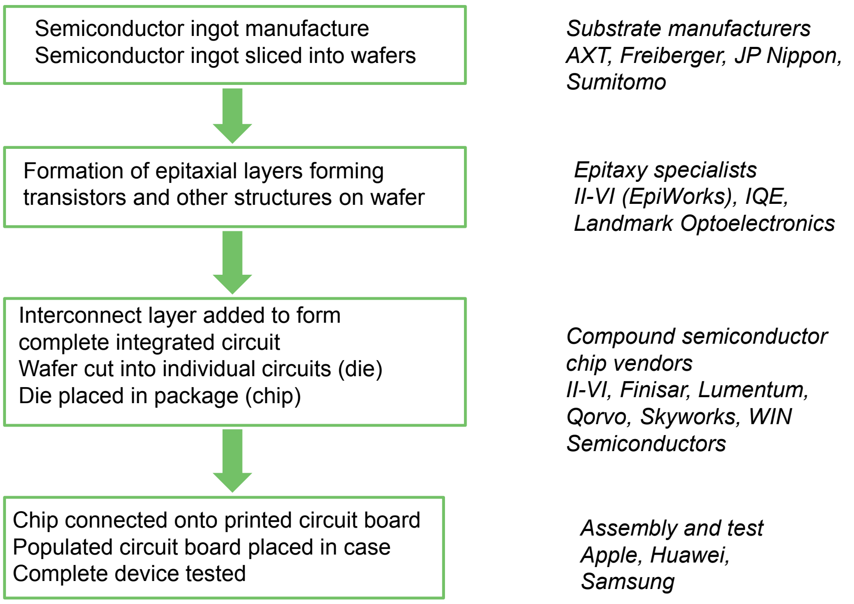
Source: Edison Investment Research

Silicon is a single element semiconductor and therefore has a fixed set of electronic characteristics In contrast, compound semiconductors are made from a mixture of elements. In contrast, by combining elements (eg gallium, arsenic, indium, phosphorus and aluminium) in different proportions, IQE can make compound semiconductor materials with a diverse range of optoelectronic and electronic properties, each optimised for a particular market segment (see Exhibit 1). These include materials that transmit and receive wireless or IR (infra-red) signals, that emit and detect light (photonics), that convert light energy to electrical energy (photovoltaics), that convert electrical energy to light (LEDs) and that can function at high voltages (power electronics). IQE has specialised in one step in the compound semiconductor supply chain, epitaxy, enabling it to offer a wider range of technologies than its competitors and many in-house epitaxy units. This gives IQE a strong competitive advantage and means that it can benefit from growth in multiple markets. It enjoyed stellar growth between 2004 and 2013 from the handset boom and is well placed to benefit from widespread use of photonics chips in portable devices, automobiles and data communications.

Epitaxy: A vital part of compound semiconductor supply chain

IQE's epitaxial manufacturing service is a critical stage of the compound semiconductor supply chain. Its compound semiconductor epitaxial wafer foundries take very thin discs of substrate (compound semiconductor, sapphire or silicon) and deposit a succession of thin layers on them. Up to 300 epitaxial layers may be deposited, each of which may be only a few atoms thick. Each separate epitaxial layer contains a different combination of elements to give specific electrical or optical properties. By precisely controlling the thickness and composition of the layers deposited on the substrate, IQE provides customised epiwafers that meet each customer's specific electrical and optical requirements. The finished epiwafers are sold to manufacturers of high-frequency chipsets and laser chips, which carry out further processing steps to create finished devices.

Exhibit 2: Compound semiconductor supply chain



Source: Edison Investment Research

The epitaxy stage is best left to the experts

Compound semiconductor processing remains a highly specialised field. Semiconductor processing facilities or foundries manufacturing silicon integrated circuits do not have the requisite experience or IP. Until 15 years ago, compound semiconductor chip vendors carried out the epitaxy stage in house, but since then many have opted to outsource the process, freeing up capital for elsewhere in the business and gaining access to a wider range of technologies. This trend has benefited IQE enormously. In 2005 only 20% of compound semiconductor epitaxial wafer manufacture was outsourced; the figure is now over 50%. The shift to outsourcing is evident in other market segments. Between one-third and a half of the VCSEL epitaxy market is outsourced. In 2016 IQE introduced an innovative nanoimprint lithography technology for InP (Indium Phosphide) wafers, encouraging more chip vendors requiring InP epitaxy to investigate outsourcing.

IQE dominates the non-captive market

The importance of the epitaxial processing stage means that the sector has seen a spate of M&A activity. For example, in February 2016, semiconductor laser specialist II-VI acquired EpiWorks. In July 2016, Infineon announced its intention to purchase Cree's RF and power substrate business, though the deal was blocked by the US government. IQE has been an active participant in this consolidation. IQE itself was formed in 1999 from a merger of two companies, one in the UK, the other in the US, each specialising in different epitaxial processing techniques addressing different market segments. A year later, it acquired Wafer Technology, a company manufacturing the substrates on which the epitaxial layers are grown. Subsequent acquisitions, eg Emcore's Electronic Materials Division in 2006 and Galaxy Compound Semiconductors in 2010, further broadened the product portfolio, while the purchase of RFMD's (now part of Qorvo) in-house epiwafer business in 2012 and Kopin's epitaxy activity in 2013 increased market share, securing key customers who would not risk switching suppliers. This sequence of acquisitions has made IQE the market leader with respect to scale and breadth of product portfolio. It has grown from a c 10% share of the non-captive wireless market in 2005 to over 55% today.

Compound semiconductor on silicon – the best of both worlds

Using compound semiconductor materials rather than silicon results in devices with superior electrical or optical properties, but has the drawback of being expensive. Partly this is related to the smaller 4" or 6" diameter wafers used in compound semiconductor processing compared with 8" or 12" for silicon. This means that there are far fewer devices produced on each compound semiconductor wafer compared with a silicon one, and also that it is not possible to use the highly efficient equipment designed for handling silicon wafers in compound semiconductor fabs. For some technologies the cost of the semiconductor material is an additional drawback. So while GaN has ideal electrical properties for making power electronics chips, the cost of GaN wafers is prohibitive, plus GaN wafers distort during high temperature processing steps with a deleterious impact on yields.

Since the substrate only acts as a support and does not form any part of the electrical circuit, one option is to form the epitaxial GaN layers on a different substrate material. Silicon would be ideal, as the wafers are inexpensive and available in the larger diameter formats, which are much more efficient to process. The snag with this option is that the crystalline lattices of the silicon substrate and the compound semiconductor do not match up. (Imagine trying to stack layers of golf balls on top of snooker balls.) As the compound semiconductors layers try to accommodate themselves to the shape of the silicon layers below, the crystal structure is deformed and the electrical and optical properties severely compromised. As a compromise, GaN epitaxy is currently deposited on SiC (silicon carbide) substrate, which is much more expensive than silicon because of the time it takes to grow SiC ingots, and is only available in small diameter formats. The resultant GaN-on-SiC devices can support power densities eight times higher than GaAs used for wireless chips, but the premium pricing means that their use is confined to niche applications, primarily defence and increasingly high-performance base stations.

IQE is a pioneer of techniques that address the compound semiconductor/silicon mismatch. In 2000 it established a dedicated facility in Cardiff. In 2009 it acquired Bath University spin-off NanoGaN to secure additional IP. In 2015 it acquired exclusive rights to Translucent's patented cREO (crystalline rare earth oxide) technology from the parent, ASX-listed Silex Systems. cREO creates a buffer layer between the silicon substrate and the compound semiconductor layer so that the latter can form properly. (Imagine a foam pad between those layers of golf balls and snooker balls.) The technique is applicable to many compound semiconductor/silicon combinations. The closest to commercial deployment is GaN-on-Si for wireless base-stations. In the longer term, the technique offers potential for a third growth wave in power electronics (see below). The technology is applicable to all of IQE's other key markets too.

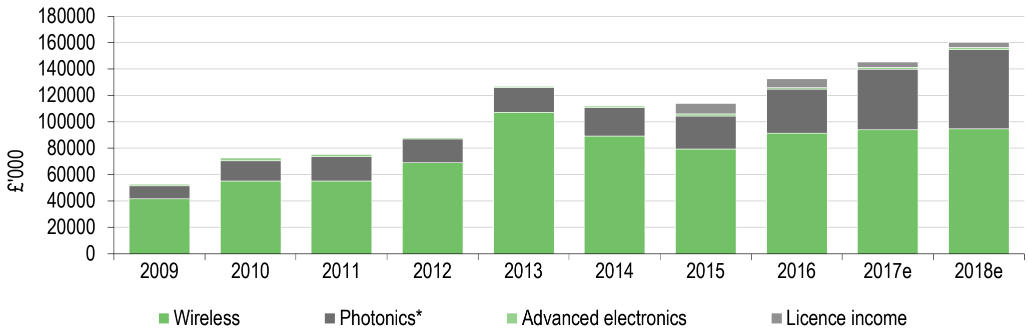
The cREO technology is important not only because of the epitaxial structures that can be created, but because it comes with 74 granted patents and 13 pending patents. This secures IQE's IP rights, reducing the risk of IP disputes in the future.

In November 2016 IQE announced a 15-month R&D programme with ASX-listed BluGlass to deposit high-quality nitride films on silicon or cREO-on-silicon using BluGlass's lower temperature processing technology. This will potentially give a lower-cost, more environmentally friendly technique for manufacturing compound semiconductors suitable for use in power electronics applications and the wireless switch and filter markets.

Markets: Diversification initiatives driving growth

The range of technologies that IQE offers (Exhibit 1) means that it is engaged in multiple markets, each with different growth trajectories. The wireless segment was the principal driver in the decade from 2004 and remains IQE's largest segment. Photonics has taken over as the primary growth engine and it is expected to retain this role during the remainder of the forecast period. Successful execution in power electronics and LED lighting could trigger a third wave of significant growth in two or three years' time. As these are very large markets, which would require very high volumes of epitaxial material, it is probable that IQE will address them through an IP licensing model rather than supply epitaxy itself. IQE started to generate revenues from licensing IP in 2015. This is currently only a small proportion (1% H117) of total revenues.

Exhibit 3: Analysis of revenues by business segment



Source: IQE, Edison Investment Research. Note: *Including Infrared.

Wireless communications (67% of H117 revenues)

Compound semiconductors key for higher specification handsets

Compound semiconductors allow electrons to travel much more quickly in them than in bulk silicon and can handle higher-voltage gradients before breaking down. This enables the creation of higher-frequency, lower noise and more power-efficient power amplifiers, which is important in mobile, satellite and wireless communications applications. In a mobile phone, the memory and data processing chips are typically silicon and the transmit and receive functions are gallium arsenide (GaAs), especially in higher-specification handsets. This is because GaAs power amplifiers operate at higher frequencies, are more efficient than their silicon counterparts and provide longer battery time.

GaAs demand linked historically to the handset market

According to Strategy Analytics' report published in October 2016, wireless applications currently account for more than 80% of all GaAs device sales. Demand from this segment has driven very strong growth over the last decade, which has been extremely beneficial for IQE. However, the report notes that the positive impact of increasing quantities of RF content per handset in more sophisticated handsets (see Exhibit 4) is likely to be almost balanced by price erosion, die shrinkage, a slowdown in the rate of growth of smartphones, and the adoption of cheaper technologies such as silicon-on-insulator (SOI) in lower specification handsets. The report concludes that the market will experience a CAGR of slightly above 0% between 2016 and 2020 with growth resuming towards the end of the period with the commencement of 5G deployments. We note that visibility of underlying demand is obscured by the frequent but irregular inventory build-ups and then correction cycles experienced by customers. For example, there was significant destocking during FY15.

Exhibit 4: Average RF content/handset

	Typical 2G	Typical 3G	Regional LTE	Global LTE
Filter content	$0.25	$1.25	$4.00	$7.25
Switching/tuning	$0.00	$0.25	$1.50	$2.25
Power amplifiers	$0.30	$1.25	$2.00	$3.25
Other	$0.00	$0.00	$0.50	$0.50
Total RF content	$0.55	$2.75	$8.00	$13.25

Source: IQE

IQE's newer technologies addressing growth applications

IQE is already supplying GaN-on-SiC for low-volume, price insensitive applications, primarily military communications and radar, which the Strategy Analytics report cited above notes are growth niches within the wider wireless market, and high-end base stations. The newer, less expensive GaN-on-Si technology potentially opens up various more price-sensitive applications in the wireless infrastructure market with existing customer MACOM, presenting near-term opportunity. We note that in September 2015 MACOM announced that it had shipped more than one million GaN-on-Si power transistors (cumulatively), suggesting that IQE's epitaxy volumes will begin to ramp up during the forecast period. IQE's compound semiconductor-on-silicon technology also provides a potential route in the medium term to regain share in the handset switch segment, which has migrated from compound semiconductor to lower cost, lower performance options, and capture share in the handset filter segment. Exhibit 4 shows that the wireless switch, filter and power amplifier markets combined are collectively three to four times the size of the market for wireless power amplifier chips alone.

Handset revenues have plateaued but other segments are growing

Following the sequence of acquisitions discussed earlier, IQE has become the dominant supplier globally with over 55% share of the wireless market. Importantly, it provides epitaxy services to all the major RF chip suppliers. This reduces its exposure to market share swings, which had previously resulted in revenue volatility. IQE's wireless revenues increased by 9% year-on-year during H117 to £47.3m, representing a very slight decline in constant currency. Demand in terms of number of chips deploying the epitaxy increased as IQE took market share, but this positive trend was offset by die shrinkage and price erosion. Our estimates model H217 sectoral sales at similar levels to H117 (IQE no longer feels that the 45/55 H1/H2 split is valid), giving a 4% increase for the year as a whole compared to FY16 and 1% growth in FY18. While we note Strategy Analytics' forecast of minimal growth for GaAs devices in the wireless sector until 5G programmes start to kick in, IQE is winning a higher proportion of clients' business, thus taking market share. Moreover, it is securing business related to products based on GaN-on-SiC technology, justifying a more optimistic growth rate than the Strategy Analytics report. Our estimates exclude volume ramp-up of GaN-on-Si because the timing depends on MACOM's customers finalising designs incorporating the new devices and deciding to move to volume production with them. We also exclude roll-out of the filter technology to take share in the wireless filter segment.

Photonics (23% of H117 revenues)

Compound semiconductors exhibit properties that convert light to electricity and electricity to light extremely efficiently. IQE has developed a range of epitaxial wafers based on two key technologies: vertical cavity surface emitting laser (VCSEL), which is used in data communications, consumer and industrial applications; and indium phosphide (InP), which is used in fibre to the premises (FTTP) and other short-haul optical networks. Crucially, since the range of applications within photonics is so diverse, demand from the photonics segment is not dependent on any one application in the way that historically wireless revenues, and consequently IQE's fortunes, were reliant on the health of the handset market. Wafer prices for photonic applications are at least twice that for wireless applications. This gives a beneficial impact on margins even though there are many more processing steps required than for wireless epitaxy

VCSELs – arrays of lasers for consumer and industrial applications

VCSELs modulate signals at frequencies up to and exceeding 25Gbps, so are ideal for high-speed communications and precision sensing applications. They provide reliable operation at distances ranging from close proximity links (centimetres) up to 500m in data centre, enterprise and campus networks. Unlike edge-emitting lasers, which emit light from the side of the chip once it has been cut, VCSELs emit a beam of light at right angles to the top of the chip. This means it is possible to test the optical properties of an individual device before the wafer has been cut up and packed into individual devices, thus improving yield and reducing the cost of production. This means that it is feasible to deploy arrays of VCSELs in consumer electronics devices (including gaming devices, smartphones and tablets) for laser focusing, 3D imaging, facial recognition, proximity sensing, hand and body tracking, and gesture recognition and in automotives for pedestrian detection, collision avoidance, parking assistance, traffic sign recognition and lane departure warning. The reduced cost also means that it is possible to create a two-dimensional array consisting of hundreds of individual light sources that collectively output a high power beam tuned to a specific frequency. This has applications in industrial illumination, 3D printing, drying and curing plastics and sintering metals.

6" VCSEL wafer production gives IQE a key competitive advantage

IQE was the first company to have a process for producing 6" diameter VCSEL wafers. As noted in the discussion on GaN-on-Si, having a higher diameter means that more devices can be manufactured at the same time, substantially reducing cost per device. Being the first to offer larger diameter VCSEL wafers means that IQE has become the preferred outsourcing supplier for VCSEL epitaxy, working in some cases directly with OEMs rather than chip or component vendors. Since it takes a significant amount of time to qualify epitaxy vendors it is likely that IQE will retain customers even if competitors begin to offer 6" format wafers as well.

InP – enabling high data rate fibre optic communications

Telecommunications companies are increasingly deploying passive optical networks (PONs) to deliver triple-play services including TV, voice over IP (VoIP) phone and internet services to subscribers. These networks are also referred to as FTTH (fibre to the home), FTTP (fibre to the premises) or FTTC (fibre to the curb) networks. These optical networks can deliver the much higher data rates that are essential for distribution of video and other internet services. Optical connections are also much more efficient than their electronic counterparts, which is particularly desirable in datacentres, where power, including that required for cooling purposes, is a significant proportion of operating costs. IQE has developed a proprietary nanoimprint lithography (NIL) technique for manufacturing distributed feedback (DFB) lasers used in these short-haul (up to 20km) networks. This novel technology has enabled it to take on InP projects that previously customers had to manufacture themselves. IQE is currently in multiple qualifications with customers for NIL technology.

Photonics is driving IQE's second growth wave

IQE is currently the dominant outsource provider of epitaxy for photonics applications. It has over 80% of the outsourced VCSEL market, which management estimates is between one-third and one-half of the total market. The company is benefiting from underlying market growth and from component vendors transitioning from a vertically integrated business model towards outsourcing wafer supply from IQE. During H117 IQE's photonics revenues grew by 48% to £15.9m, reflecting acceleration of development activity for multiple VCSEL and InP programmes combined with volume VCSEL ramp-up on the multiple, multi-year contracts for a consumer application starting in June.

In February 2017 industry analyst MarketsandMarkets predicted that the global photonics market would grow from US$955m in 2015 to US$3,124m by 2022, a CAGR of 17.3%. We model above market growth for IQE: 49% in FY17 and 40% in FY18, to reflect the impact of the multiple, multi-year contracts to supply VCSEL epitaxy for mass-market consumer applications. Noting that the iPhone X contains lasers for the 3D mapping of facial characteristics powering the Face ID security functionality, and that IQE has the dominant market share, we infer that the end-customer of these volume VCSEL ramp-ups is Apple, though clearly confidentially agreements preclude IQE from confirming this. We will review these segmental estimates, which currently take a cautious view of VCSEL ramp-up relating to the iPhone X ramp-up, when data on the first few weeks of iPhone X sales are available. This will give an idea of whether consumers will pay $1,000 for a phone, whether the embarrassing Face ID glitch at the launch is a recurring phenomenon, and of availability, which may be limited by bottlenecks in the OLED supply chain. Some sense of the potential upside is given by VCSEL laser supplier Lumentum's August results call. Lumentum, which is rumoured to be an Apple supplier, received bookings for 3D sensing devices totalling c US$200m for the remainder of calendar 2017 compared with US$5m actual revenues for the quarter ended June 2017 and increased VCSEL laser capacity by 25-30% from what it had anticipated only three months previously. There is also upside to our estimates from other VCSEL and InP development programmes moving to volume production during FY18.

Infrared sensing (8% of H117 revenues)

Compound semiconductors containing antimonides are used to manufacture emitters and detectors of light in the infrared part of the spectrum. Historically, this has been a high-margin business focused on defence applications such as night vision equipment. However, IQE has started to produce the industry's first 6" indium antimonide wafers, thus improving the economics of production as the larger diameter means more devices per wafer. This permits the deployment of infrared chips in high-volume, cost-sensitive applications such as the measurement of environmental pollutants from industrial processes and automotive engines; non-invasive devices to monitor levels of oxygen, sugar or alcohol in the bloodstream or detect indictors of cancer; stand-off detection of explosives and biological threats; and specialised free space communication systems.

Potential for strong growth as IQE moves into consumer applications

Following the acquisition of Galaxy Compound Semiconductors in 2010, IQE is the largest supplier of infrared materials globally, with over 80% market share. Sectoral revenues grew by 19% year-on-year during H117 to £5.6m. Our estimates model a 6% rise in sectoral sales during both FY17 and FY18 (management guidance is for c 10%). We believe faster growth is achievable in the medium term given the potential expansion into consumer applications.

Power electronics – potential to drive third wave of growth

Gallium nitride (GaN) epitaxy mounted on a less expensive substrate is used for making power electronics chips because GaN can withstand higher voltages than silicon and is better at removing waste heat energy. Emerging applications include power supplies for data-centres, LiDAR, electric transport and wireless power. Revenues attributable to the power semiconductor market are not material at present and are included in advanced electronics (CMOS++) revenues. Until IQE begins to ship meaningful volumes of the material, which management estimates is two to three years off, we will treat revenues from this sector as upside to our estimates.

The GaN market is very attractive for IQE as it represents one of the largest growth opportunities for compound semiconductors. Management estimates that the power switching market (AC/DC and DC/DC) on its own has the potential to be three to four times larger than the current wireless power amplifier chip market. Market analyst Yole Développement has estimated the GaN power semiconductor device market to be worth less than $10m in 2015 (note: the wafer market will be smaller), but forecasts that this will grow at an estimated 86% CAGR through 2016-21 to reach $280m in its baseline scenario.

Concentrated photovoltaic (CPV) market represents upside

CPV solar cells use lenses or mirrors to concentrate light up to 1,000x onto a small area of semiconductor material. Compound semiconductor material is able to withstand the high temperatures involved better than silicon. Moreover, it is possible to tailor the compound semiconductor material to have multiple layers of different semiconductors, each tuned to absorb a different frequency of light and convert it to electricity. This means that a higher proportion of the incident light energy is converted to power than with conventional silicon-based solar cells. IQE and its partner, Solar Junction, are currently focused on space applications of compound semiconductor technology. For these applications the weight constraints imposed by needing to launch satellites into orbit are more important than the relative economics of deploying compound semiconductor PV (more efficient but more expensive) versus conventional solar cells, which determine terrestrial deployments. The greater efficiency of compound semiconductor PV cells gives more power, and thus more capacity for data-transmission for the same weight payload. Payload constraints also make CPV a good option for solar powered drones.

Revenues from this sector were not material in H117, though ongoing development activities encourage management to expect good commercial progress in the next two to three years. Until IQE begins to ship meaningful volumes of the material, we will treat revenues from this sector as upside to our estimates.

Advanced electronics (1% of H117 revenues)

As noted earlier, IQE has been developing techniques for combining compound semiconductor material with silicon since 2000. Its GaN-on-Si technology is already being used for some wireless applications that are close to commercialisation and the revenues attributed to the Wireless segment. Other compound semiconductor/silicon technologies that are further from commercialisation are categorised as “Advanced electronics”. These include technology for the power electronics market discussed above and technology suitable for both next generation wireless chips and micro-processors. This latter technology, which IQE is working on together with a number of partners, and which we infer from patent filings to include Intel, creates hybrid integrated chips with areas of compound semiconductor material and traditional CMOS on a common silicon substrate. This would enable the manufacture of highly integrated devices combining a power amplifier in compound semiconductor with a filter and switch stack in CMOS and ultra-high speed processing chips. These developments are still in the research phase, although the Translucent acquisition has given the programme a substantial boost. Management expects this novel technology to deliver significant revenues over the next three to five years.

Revenues attributable to this segment totalled £0.7m during H117 (H116: £0.9m). We model 3% segmental growth in both FY17 and FY18 to reflect the long gestation period for the hybrid compound semiconductor/silicon chips.

Licence income (1% of H117 revenues)

Licence income is a relatively new revenue stream for IQE. The first revenues were generated in FY15 following the formation of JVs in the UK and Singapore. The JV in Singapore is with WIN Semiconductors and Nanyang Technological University. The JV in the UK is with Cardiff University. These JVs form the nuclei of compound semiconductor clusters in which IQE can commercialise the academic research that has been prototyped by the JVs, taking novel materials from prototypes to high-volume production for industry partners. For example the Cardiff JV is at the centre of a new £150m UK National Catapult to develop and build next-generation compound semiconductors, creating a national and European centre of excellence in South Wales. The proposed capacity expansion to support volume VCSEL ramp-up is being supported by this Catapult project, which will enable IQE to occupy the new facility rent-free for three years.

Segmental revenues are expected to be relatively lumpy. They totalled £1.0m in H117. H116 segmental revenues totalling £3.5m were higher because they included one-off upfront fees. We model FY17 and FY18 licence income at FY16 levels. This additional revenue stream is likely to become more significant in the longer term if IQE's technology is deployed in applications such as general-purpose LED lighting and solar power, where IQE would not be able to meet demand for the volume of epitaxy required from its own resources.

Sensitivities

- **Handset exposure**: with 67% of H117 sales coming from wireless, IQE's financial performance remains exposed to changes in dynamics within this segment. With blanket coverage of the main RF chip suppliers, exposure to OEM and chip vendor market share swings have now been largely mitigated, but sales are heavily influenced by the health of the handset industry, and inventory cycles. In the medium term, we expect IQE's reliance on the handset market to diminish as multiple VCSEL and InP programmes move to volume production. In the short term, however, the ramp-up in volumes for programmes we infer are connected to the iPhone X not only increases exposure to the handset market generally, but also increases exposure to a single handset supplier. The troubles at Imagination Technologies and Wolfson Microelectronics illustrate the danger of this reliance. Since IQE has such a large share of the outsourced VCSEL market, is the first and, we believe, the only vendor so far to manufacture more cost-effective 6" VCSEL wafers, and customers are extremely unlikely to risk compromising device performance by switching to alternative suppliers for the sake of saving several cents on a $1,000 device, we believe that Apple is effectively locked in to the existing epitaxy supply chain for several years. Were Apple to decide to switch epitaxy provider at the end of this period, it is likely that IQE would have found other handset manufacturers to work with as well, reducing the impact of a move.

- **Uncertainties in markets that are still not yet developed**: IQE has opportunities in many end-markets: power electronics, chip-to-chip interconnect, gesture recognition, industrial heating, CPV, environmental monitoring and non-invasive blood monitoring. If any of these opportunities is successful and the wireless market remains stable, there could be significant upside to our estimates, but the timing and rate at which revenues from these applications could grow is difficult to gauge.
- **Currency**: IQE's presentational currency is sterling, but the company earns the large majority of revenues in US dollars. Translational risk is therefore unavoidable. Transactional risk is reduced, where possible, through matching input costs with revenues, although a proportion of costs is in sterling. Debt is denominated primarily in dollars.

Valuation

Scenario analysis

Our current estimates take a cautious view of the rate of VCSEL volume ramp-up for the remainder of the forecast period. We have assumed that this ramp-up will be driven by the iPhone X, but until the first few weeks of sales data for the new phone is released we will not have visibility of consumer appetite for it, or for availability. Moreover, while the multiple, multi-year contracts IQE has relating to iPhone X deliveries commit the customers to purchasing a pre-agreed proportion of their epitaxy requirements from IQE, they do not specify the absolute level of deliveries. We therefore present a scenario analysis showing potential upside from a faster ramp-up than our current estimates, which model £8.3m iPhone X-related sales in FY17 (c 6% of total) and £20.1m in FY18 (c 13%).

Exhibit 5: Scenario analysis

		Number of phones with VCSEL content shipped per year(m)				
		100	150	200	250	300
		VCSEL revenues (£m)				
VCSEL phone (US$)	0.40	26.4	39.6	52.8	66.0	79.2
	0.50	33.0	49.5	66.0	82.5	99.0
	0.60	39.6	59.4	79.2	99.0	118.8
	0.70	46.2	69.3	92.4	115.5	138.6
	0.80	52.8	79.2	105.6	132.0	158.5
		Total EPS (p): 30% EBITA margin				
VCSEL/phone (US$)	0.40	3.3	3.7	4.1	4.5	4.9
	0.50	3.5	4.0	4.5	5.0	5.5
	0.60	3.7	4.3	4.9	5.5	6.1
	0.70	3.9	4.6	5.3	6.0	6.8
	0.80	4.1	4.9	5.7	6.6	7.4
		Total EPS (p): 40% EBITA margin				
VCSEL/phone (US$)	0.40	3.5	4.1	4.6	5.2	5.7
	0.50	3.8	4.5	5.2	5.9	6.6
	0.60	4.1	4.9	5.7	6.6	7.4
	0.70	4.4	5.3	6.3	7.2	8.2
	0.80	4.6	5.7	6.8	7.9	9.0
		Total EPS (p): 50% EBITA margin				
VCSEL/phone (US$)	0.40	3.8	4.5	5.2	5.9	6.6
	0.50	4.2	5.0	5.9	6.7	7.6
	0.60	4.5	5.5	6.6	7.6	8.6
	0.70	4.8	6.0	7.2	8.4	9.6
	0.80	5.2	6.6	7.9	9.3	10.7

Source: Edison Investment Research. Note: Green values indicates reactor capacity in addition to that on order required.

Our analysis calculates annualised revenues and EPS based on the potential run-rate at the end of FY18. We calculate the potential revenues derived solely from the ramp-up of VCSELs for the new iPhone X and subsequent smartphones from competitors, as by this stage it is highly likely that other smartphone manufacturers will have launched their own models with 3D sensing. To give some context for volumes shipped, we note that Apple shipped 212m iPhones during 2016. To give some context for the value of VCSEL content per phone, we note that the initial iPhone X devices will have a laser costing US$3-4/unit to capture the 3D facial information required for the Face ID function. Adverts for the new phone suggest that later editions will have a more complex laser costing c $5 to capture 3D information about a consumer's environment, which can be used in augmented reality applications that merge a consumer's actual environment with fantasy. We assume that 10% of the value of these lasers resides in the epitaxy supplied by IQE and that IQE has 85% market share.

We calculate the incremental PBT associated with this range of revenues for three values of EBITA margin – 30%, 40% and 50% (we believe that contribution margin may be substantially more than the 50% we have historically used for IQE, but need to allow for the incremental fixed costs associated with supporting this volume programme) – and combine this with our FY18 PBT estimate from March 2017, which excluded any profit from a volume VCSEL ramp-up. We model interest at the level shown in our current set of estimates because these reflect investment in additional capacity announced in July 2017, which we assume is sufficient to support the higher revenue levels associated with the volume VCSEL programme. Although IQE is not currently paying tax as it has sufficient tax losses available to shield future tax payable of c £39.9m, we model a 25% tax rate.

Exhibit 6: Multiples of listed peers

Name	Market cap ($m)	EV/sales 1FY (x)	EV/sales 2FY (x)	EV/EBITDA 1FY (x)	EV/EBITDA 2FY (x)	P/E 1FY (x)	P/E 2FY (x)
Substrate							
AXT INC	315	2.5	2.2	15.7	11.6	31.3	20.4
Epitaxy							
GCS Holdings INC	175	2.3	2.0	11.6	-	15.9	11.0
Intelliepi INC	108	3.4	3.0	14.6	10.8	24.1	18.6
Land Mark Optoelectronics	1,154	16.1	11.6	30.3	18.1	48.8	28.8
S.O.I.T.E.C.	1,717	4.8	3.7	23.5	15.3	50.4	26.2
Visual Photonics Epitaxy Co	365	4.3	3.9	13.3	10.5	22.7	18.5
Win Semiconductors Corp	2,478	4.9	4.2	12.0	9.6	23.1	17.4
Broadcom	100,828	6.3	5.9	9.6	9.5	15.6	14.1
Qorvo Inc	9,284	3.1	2.8	9.3	8.1	13.2	11.2
Skyworks Solutions Inc	19,636	5.0	4.5	11.4	10.2	16.7	14.7
Opto-electronics							
II-VI INC	2,414	2.3	2.0	-	-	19.4	13.8
Emcore Corp	241	1.4	1.3	9.8	8.5	16.9	14.3
Finisar Corporation	2,480	1.4	1.2	6.7	5.7	13.9	10.6
Lumentum Holdings Inc	3,522	2.7	2.4	12.1	10.5	19.0	16.1
Mean		**3.7**	**3.2**	**13.8**	**10.7**	**23.7**	**16.8**
IQE	1,219	6.7	6.1	27.6	24.6	41.9	38.3

Source: Bloomberg. Note: Grey shading indicates exclusion from mean. Calculated on historic debt. Prices at 13 September 2017.

The share price has trebled since the interims in March as investors have speculated on the potential impact of volume VCSEL programmes on earnings. As a result, the share price already anticipates substantial upgrades. If we take the peer group FY18e P/E average of 16.8x as a guide and apply it to the current IQE share price of 131.00p, this would imply that investors are pricing in FY18 EPS of around 8.1p. We note that this is towards the upper end of the range explored in our scenario analysis, so is feasible, but would require further capital expenditure in addition to the reactors already on order and included in our model. (Our model has c £20.0m capex generating c £23m incremental revenues.) Importantly, even if the rise in VCSEL volumes is not realised from deliveries related to the iPhone X, IQE is engaged in multiple photonics development programmes with the potential to generate similar levels of growth.

Another approach is to look at P/E multiples for Land Mark Optoelectronics and SOITEC rather than the entire sample. As with IQE, both of these companies are expected to benefit from demand for photonics epitaxy for opto-communications applications. While IQE's FY17e P/E multiple is relatively high, it is less than the equivalent multiples for these two companies, which may be considered its closest peers even though they both offer a much more limited range of epitaxy than IQE does and are therefore exposed to the risk associated with a focus on fewer market segments.

H117 financials and estimates

Earnings development distorted by one-off H116 licence fees

Group revenues increased by 12% year-on-year during H117 to £70.4m. Wafer revenues rose by £9.9m (17%) to £69.4m, driven by the strong growth in photonics revenues discussed earlier and favourable foreign exchange tailwinds of c 10%. Licence revenues dropped by £2.5m to £1.0m as H116 benefited from one-off upfront payments. Gross margin declined by 2.8pp to 25.6% reflecting a lower proportion of revenues from licence fees. Adjusted sales, general and administrative expenses were tightly contained, rising by only 3%. The combination of higher wafer revenues on a fairly static cost base resulted in a 32% jump (£2.3m) in adjusted operating profit from the wafer manufacturing operations to £9.6m. However, this was offset by the reduction in licence fees, resulting in small (2%) decrease in group adjusted operating profit to £10.6m.

Cash generated from operations reinvested for growth

Conversion of adjusted operating profit (£10.6m) to cash from operations (£11.2m) was 106%, lower than the 115% achieved in H116 because of a £3.7m increase in working capital related to the volume VCSEL ramp-up. £15.4m was invested in capex (£5.8m) and product development (£9.6m), primarily for volume VCSEL production. Net debt grew by £2.3m to £41.9m, and gearing by 0.9pp to 21.2%.

Estimates unchanged until clarity on the rate of VCSEL ramp-up

We revised our estimates following the trading update in July to reflect a modest ramp-up in VCSEL wafer volumes during H217 and into FY18 resulting from the onset of deliveries of VCSEL wafers for multiple, multi-year contracts addressing mass-market consumer applications. At the same time, we increased fixed costs, capitalised R&D and capex to support the VCSEL ramp-up. As discussed in the valuation section, we are taking a cautious approach to the rate of ramp-up for the moment and will revise our estimates when there is clarity on consumer uptake and availability of the iPhone X. We model a 10% increase in group revenues in both FY17 and FY18 to reach £160.3m in FY18. Although the price IQE charges for photonics wafers is several times that for wireless wafers, the processing is more complex and IQE is putting in additional fixed costs as discussed, so our model shows EBIT margin rising by only 0.8pp to 17.5% in FY17, then decreasing to 17.1% in FY18. This results in a 9% increase in EPS in FY17, and 10% in FY18 to 3.57p.

Management is planning for a faster VCSEL ramp-up

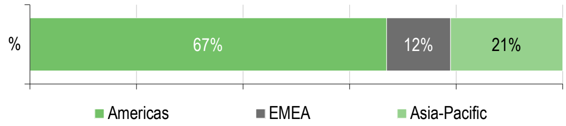
Although we are taking a cautious approach in our estimates, management is planning for a faster ramp-up than our model. Noting that H218 demand was likely to be higher than it had initially anticipated, in July the board of IQE committed to a capacity expansion plan. It is leasing new premises in South Wales and placed orders for the equipment, initially five reactors, which management expects will come on line mid-2018. This is a c 5% increase in capacity. The premises have the space to hold up to 100 reactors, roughly the same as IQE has at present. Noting that current capacity can support up to an estimated US$300m (£230m) in revenues, and the new reactors will be used for photonics wafers, which are at least double the value of wireless wafers, we estimate this provides capacity to support c £250m revenues. We note that if deliveries for VCSEL contracts relating to the iPhone X do not ramp up to utilise this capacity, it will be used to fulfil volume orders for other programmes as they reach the commercialisation phase.

Our estimates model £6.6m investment in working capital, £11.0m R&D and £20.0m capex during FY17, resulting in a £4.9m increase in net debt to £44.5m, representing 21% gearing. Substantially lower levels of capex (£4.5m) and capitalised R&D (£7.5m) in FY18 then give a reduction in net debt to £26.9m at end FY18.

Exhibit 7: Financial summary

£000s	2015	2016	2017e	2018e
Year end 31 December	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS				
Revenue	114,024	132,707	145,346	160,303
Cost of Sales (Inc D&A + SBP)	(81,585)	(96,292)	(105,303)	(115,664)
Gross Profit	32,439	36,415	40,043	44,639
EBITDA	29,001	31,730	35,462	39,665
Depreciation and Amortisation	(10,024)	(9,611)	(10,000)	(12,300)
Operating Profit (before amort. and except.)	18,977	22,119	25,462	27,365
Acquired Intangible Amortisation	(1,208)	(1,327)	(1,327)	(1,327)
Exceptionals	5,398	1,915	0	0
Share based payments	(2,001)	(2,042)	(3,000)	(3,000)
Operating Profit	21,166	20,665	21,135	23,038
Underlying interest	(1,403)	(1,489)	(2,000)	(1,500)
Exceptionals	(387)	(144)	0	0
Profit Before Tax (norm)	17,574	20,630	23,462	25,865
Profit Before Tax (FRS 3)	19,376	19,032	19,135	21,538
Tax	773	408	500	500
Profit After Tax (norm)	18,066	21,440	23,462	25,865
Profit After Tax (FRS 3)	20,149	19,440	19,635	22,038
Average Number of Shares Outstanding (m)	662.6	671.5	680.5	684.1
EPS - normalised (p)	2.60	3.00	3.26	3.57
EPS - (IFRS) (p)	3.00	2.87	2.88	3.21
Dividend per share (p)	0.0	0.0	0.0	0.0
BALANCE SHEET				
Fixed Assets	174,207	215,154	234,827	233,200
Intangible Assets	86,843	103,972	109,645	111,018
Tangible Assets	65,154	85,001	99,001	96,001
Other	22,210	26,181	26,181	26,181
Current Assets	48,909	64,323	68,506	95,557
Stocks	21,215	28,498	34,213	38,755
Debtors	23,050	30,868	34,278	39,163
Cash	4,644	4,957	14	17,639
Other	0	0	0	0
Current Liabilities	(48,050)	(46,012)	(48,572)	(50,297)
Creditors	(44,809)	(38,360)	(40,920)	(42,645)
Short term borrowings	(3,241)	(7,652)	(7,652)	(7,652)
Long Term Liabilities	(28,032)	(39,021)	(39,021)	(39,021)
Long term borrowings	(24,626)	(36,854)	(36,854)	(36,854)
Other long term liabilities	(3,406)	(2,167)	(2,167)	(2,167)
Net Assets	147,034	194,444	215,740	239,439
CASH FLOW				
Operating Cash Flow	20,971	22,463	28,896	31,963
Net Interest	(1,403)	(1,489)	(2,000)	(1,500)
Tax	(459)	(839)	(839)	(839)
Capex and capitalised R&D	(10,002)	(19,060)	(31,000)	(12,000)
Acquisitions/disposals	0	(11,250)	0	0
Financing	544	578	0	0
Dividends	0	0	0	0
Net Cash Flow	9,651	(9,597)	(4,943)	17,624
Opening net debt/(cash)	31,251	23,223	39,549	44,492
HP finance leases initiated	0	0	0	0
Other	(1,623)	(6,729)	0	0
Closing net debt/(cash)	23,223	39,549	44,492	26,867

Source: IQE accounts, Edison Investment Research

Contact details	Revenue by geography (FY16)
IQE 2 Pascal Close St. Mellons, Cardiff CF3 0LW +44 (0)2920 839 400 www.iqep.com	

Management team

CEO: Dr Andrew Nelson OBE, BSc, PhD, FREng	CFO: Phillip Rasmussen BSc, ACA
Dr Nelson joined BT in 1981 where he led the group responsible for the development of advanced optoelectronic devices for optical fibre communications and subsequently managed the technology transfer from BT to Agilent for mass production. He co-founded EPI in 1988. This merged with QED in 1999 to form IQE. He was appointed CEO of IQE in April 1999. He is a member of the high-level group appointed by the EC to oversee the implementation of key enabling technologies throughout Europe.	Phil Rasmussen qualified as a chartered accountant in the audit practice of Coopers & Lybrand, a predecessor firm of PwC. Before joining IQE, he was director of Transactions Services with PwC and worked with IQE on two major acquisitions during 2006. He was appointed CFO in 2007.
Chairman: Dr Godfrey Ainsworth BSc, PhD, FCA	
Dr Ainsworth qualified as a chartered accountant. After a period in the accountancy profession, he founded Gambit Corporate Finance in 1992, specialising in corporate finance services. He was appointed to the board of IQE in 1997 and became chairman in 2002. He is chairman of Seren Photonics and director of Omniport Holdings.	

Principal shareholders	(%)
T Rowe Price	9.4%
Hargreaves Lansdowne Asset Management	7.3%
Toronto Dominion Bank	7.2%
Barclays plc	6.4%
AXA	5.8%

Companies named in this report

II-VI Inc (IIVI:US), Anadigics Inc. (ANAD:US), BluGlass (BLG:ASE), Broadcom Inc. (AVGO:US), Emcore Corp (EMKR:US), GCS Holdings Inc. (4991:TT), IntelliEPI Inc. (4971:TT); Kopin Corp. (KOPN:US), Landmark Optoelectronics Corp (3081:TT), MACOM (MTSI:US); Qorvo Inc. (QRVO:US), Soitec SA (SOI:FP), Silex Systems Pty Ltd (SLX:AU), Skyworks Solutions Inc. (SWKS:US), Sumitomo Corp. (8053:JP), Virtual Photonics Epitaxy (2455:TT), WIN Semiconductors Corp. (3105:TT)