IQE Plc submission to the request for evidence in respect of the inquiry into the Semiconductor Industry in the UK

June 2022

Introduction to IQE Plc

IQE Plc is the world's leading compound semiconductor wafer manufacturer, headquartered in Cardiff UK and listed on the London AIM market. The company operates a global manufacturing footprint in the UK (two sites in South Wales, one in Milton Keynes), USA (four sites) and in Taiwan. In South Wales, the company operates from St Mellons in Cardiff and a state-of-the-art new 'mega-foundry' constructed in Newport. A range of products are produced in the UK including materials for 3D sensing, servicing a major premium smartphone supply chain. The company has circa 700 employees, including over 280 in the UK, and had revenues of £154m in 2021. IQE's market capitalisation is over £300m.

The company is a member of the South Wales compound semiconductor cluster which also includes Cardiff and Swansea Universities, the Compound Semiconductor Applications Catapult, Nexperia, SPTS and Microsemi.

The company's Chief Executive Officer Americo Lemos, joined the company in January 2022 from Global Foundries, a major semiconductor business in the USA. Mr Lemos has over 25 years of experience in the semiconductor industry in Silicon Valley and has also worked extensively in Asia. The company has an experienced Board of Directors including Chairman Phil Smith (formerly Chairman and CEO of Cisco UK) and Tim Pullen (formerly CFO of Arm Limited).

Compound semiconductors have superior performance characteristics to traditional Silicon based semiconductors. They operate efficiently at high power, high frequency and have the ability to emit and detect light (ie lasers). Compound semiconductors are essential components in macro technological trends such as electric and autonomous vehicles, 5G communications, the 'Internet of Things', the 'metaverse' and the drive for net carbon zero. Without compound semiconductors, these trends cannot exist.

IQE produces compound semiconductor wafers using the process of epitaxy in which it has over 30 years of experience, during which time it has amassed significant intellectual property. Epitaxy is the process by which different materials can be grown in crystalline form in layers to form a compound semiconductor epi-wafer. IQE sells these wafers to semiconductor chip companies across the world, with over 90% of revenues coming from outside of Europe.

Executive Summary

The UK currently has a limited manufacturing presence within the global semiconductor industry. This represents a strategic risk to UK security and industry. Targeted interventions are required to enable the advancement of innovation, science and technology, with a powerful and focused semiconductor strategy.

Catching up on advanced silicon-based technologies, which are now dominated by the US and Asia, is not possible due to investment and learning barriers. However, targeted investment in fast-growing areas of advanced technology in which the UK is still a world leader affords the opportunity

for the creation of national champions that will expand the UK's connections to and influence in the global semiconductor industry. Such champions, in sectors such as compound semiconductors would represent a strategic foothold in the industry, create high productivity jobs and economic growth, contribute to national security and be a key component in the UK's carbon net zero strategy.

IQE has responded to this inquiry to highlight the world leading capability that exists in the UK, which affords the UK, with targeted interventions and investments, to create a strategic foothold in the global semiconductor industry.

Responses to Questions

1. What is the current and future anticipated demand for common products built with semiconductor materials (e.g. computer chips) both in the UK and globally?

1.1 The global semiconductor industry grew by over 21% in the year to April 2022 (*Source: SIA Semiconductor Industry Association June 2022*). This figure would have been even higher if it were not for supply chain constraints in some parts of the industry.

1.2 A consistently high growth rate in the demand for semiconductor products is expected to continue for many years, fuelled by macro technological trends including

(i) The ongoing digitalisation of work and home lives which was accelerated during the pandemic;
(ii) Next generation communications networks, including 5G and WiFi 6;
(iii) Intelligent transportation, including electrified and autonomous vehicles;
(iv) The Internet of Things (connected devices, smart cities, smart grids, etc);
(v) The metaverse (digital interaction with connected virtual experiences including augmented and virtual reality);
(vi) Next generation defence and security applications;
(vii) The drive for net zero carbon emissions.

1.3 As well as driving demand for semiconductors in general, there will be an increasing proportion of compound semiconductors, enabling the power, connectivity, sensing and display requirements of the technologies associated with these macro trends.

1.4 According to Yole Developpement, an independent industry analyst, compound semiconductor demand for photonics (sensing) applications will grow by 15% CAGR (compound annual growth rate) in the period 2021-26, for radio frequency (connectivity) applications by up to 17% CAGR and for power applications by between 35% and 65% CAGR.

1.5 The automobile is a good example. The automotive industry is experiencing an exponential increase in the number of chips in a car.

(i) Chips for power conversion for electric powertrains and fast charging;

(ii) Chips for connectivity;

(iii) Sensors for Advanced Driver Assistance Systems (ADAS) and ultimately for autonomous driving;

(iv) Chips for artificial intelligence, navigation, infotainment and safety systems.

A modern car can have as many as 3,000 chips. This is set to increase further with the Intel CEO predicting in Sept 2021 that by 2025 chips will make up 12% of premium vehicle material costs. Many of these additional chips will require an increasing amount of compound semiconductor material for advanced sensing applications and electrification, which in turn are essential to the UK Government's vehicle electrification and net carbon zero targets.

1.6 Across all aspects of our lives, from consumer products to industry and the environment, these technological trends will increase demand for semiconductor chips. As Silicon technologies

reach their limits (the end of Moore's Law *), compound semiconductors will deliver the next wave of innovation.

** Moore's Law states that the number of transistors on a microchip doubles about every two years. This observation by Gordon E. Moore, co-founder of Intel, proved to be correct over many years. However, the number of transistors on a microchip eventually reaches limits due to the laws of physics. As such, the performance of advanced silicon technologies will slow down. In order to maintain the pace of innovation, advanced solutions such as compound semiconductors are required.*

2. What is the UK's semiconductor supply chain and is this secure? If not, how can this be improved? What specific strengths does the UK have to contribute to regional or global semiconductor supply chains? How competitive is the UK within the global context of the semiconductor industry?

2.1 Advanced Silicon technologies are dominated by Taiwan, Korea and the USA. Two companies, TSMC in Taiwan and Samsung in Korea, have over 80% of advanced Silicon foundry capacity. With an increasing reliance on technology, the UK economy and security is dependent on a small number of companies and nations for a supply of critical components. The vast majority of semiconductor chips used in technology products manufactured in the UK or imported into the UK are designed and manufactured outside of Europe.

2.2 The UK has been successful in semiconductor design and intellectual property with some high-profile companies enjoying multi-year growth associated with architectures for Central Processing Unit (CPU) and Graphics Processing Unit (GPU) used for computing and artificial intelligence (AI). However, the manufacture of these products is performed outside of the UK, typically in the USA or Asia.

2.3 Whilst semiconductor manufacturing volumes in the UK are relatively small, it is home to the world's leading compound semiconductor wafer manufacturing company, IQE Plc. IQE is a global business, operating from headquarters in Cardiff, with a state-of-the-art epitaxy foundry in Newport, which, when full, will be the world's largest compound semiconductor epitaxy foundry. The wafers produced by IQE are used by us all, every day. IQE's wafers are the material at the heart of power amplifiers for communications networks and handsets, 3D sensing modules in premium smartphones and advanced sensing applications for aerospace and security applications.

2.4 So whilst the UK is dependent on the rest of the world for most current semiconductor technologies, it still leads in next-generation compound semiconductors and this represents the best chance for the UK to create and maintain a strategic foothold in the global semiconductor industry.

3. Are there opportunities for strengthening different parts of the current UK semiconductor industry? What are the potential weaknesses and strengths of the UK semiconductor industry to meet future requirements of electronic device manufacturing?

3.1 Manufacturing is key to supply chain resilience. Intellectual property and design expertise are important aspects of the semiconductor supply chain but these activities can be moved around the world relatively easily. Given the physical nature of semiconductor manufacturing, involving large scale and capital-intensive facilities, this part of the supply chain has low geographic mobility.

3.2 It is these manufacturing foundries which in some parts of the semiconductor industry have become capacity constrained, leading to semiconductor shortages. Building new capacity is not straightforward or quick to do. It requires deep expertise, significant capital funding and several years. Certain countries have tried to do so, investing Billions in the process, with limited success. The opportunities for establishing Silicon manufacturing in the UK are realistically limited.

3.3 The key opportunity for the UK to strengthen semiconductor manufacturing is in compound semiconductors. At the heart of this is IQE Plc, the world's leading compound semiconductor wafer manufacturer. IQE has invested significantly in infrastructure in recent years including the construction of a state-of-the-art epitaxy foundry in Newport, South Wales. This facility affords significant expansion opportunity.

3.4 The key strengths for the UK in meeting demand for the semiconductor requirements of electronic device manufacturing are: its skilled talent base, academic capability and research activity, chip design capability and intellectual property, its leading global position in compound semiconductors supported by a Government policy that permits the sale of (non-sensitive) technologies around the world.

3.5 The potential weaknesses for the UK in meeting demand for the semiconductor requirements of electronic device manufacturing are: the rising cost of labour and energy in the UK relative to global competitors, low levels of semiconductor manufacturing capacity relative to peers and Government policy on subsidies (particularly relating to capital projects) relative to other nations that are investing in building semiconductor industries.

3.6 Investing in the compound semiconductor supply chain in the UK would create a thriving industry in a growth sector, enabling domestic manufacture of high value and strategic components used in a wide range of electronic device manufacture, which in turn will expand due to the multiplication of macro trends.

3.7 Expansion of the semiconductor industry will provide high productivity and high value jobs as well as significant economic growth and increase in exports. For example, just filling IQE Plc's foundry in South Wales would create over 400 high value direct jobs, over 2,000 indirect jobs, over £200m of Gross Value Add (GVA) per annum.

4. In which industries does the UK not have an end-to-end semiconductor supply chain? Are there any opportunities for these supply chain gaps to be filled within the UK?

4.1 The UK does not have any end-to-end semiconductor supply chains, or even a substantial presence in the manufacturing of Silicon technologies.

4.2 The UK has a critical component in compound semiconductor supply chains in IQE Plc.

4.3 The incubation of design companies based on compound semiconductors and the potential creation of a compound semiconductor chip foundry within the UK are the key opportunities to fill supply chain gaps in compound semiconductors.

4.4 It is likely, from today's start point, that the establishment of end-to-end semiconductor supply chains will take significant time and investment. Indeed, for advanced Silicon technologies, this is unlikely to be a realistic aim due to prohibitive cost and learning factors.

4.5 Despite trends of de-globalisation in the technology and semiconductor industry, the semiconductor industry remains interconnected. As such, having strategic footholds in the industry is more important in the near term than creating end-to-end supply chains. Such footholds create influence and establish resilience and security of supply, as well as representing commercial and political bargaining chips. Creating national champions in areas of the semiconductor industry in which it is feasible for the UK to take a leading position, would create such footholds.

5. How can the Government strengthen semiconductor research and innovation? Are there any current areas of weakness in the present Government strategy to semiconductor innovation? Is there effective communication between the various stakeholders within the UK's semiconductor ecosystem?

5.1 The key to sustainable innovation on a large scale is having scaled industry champions. All of the world's large semiconductor champions invest a high proportion of income back into research and development as part of their growth strategies.

5.2 Targeted investment by UK Government in semiconductor businesses with a technological lead, to enable them to scale up production, will lead to the creation of national champions. Such national champions will have the production capacity to allocate a proportion to R&D and sustainable cash generation to invest a proportion of income in these activities.

5.3 These champions also create a halo effect associated with academic research and incubation businesses that emerge in adjacent markets and complementary parts of the supply chain, which further fosters innovation. This in turn will provide a boost for productivity, jobs and economic growth.

5.4 A key opportunity for the UK is in scaling compound semiconductor technologies. Targeted investment to support the migration from 150mm to 200mm wafers for example, creates the opportunity for the UK to link its leading compound semiconductor industry with the silicon industry (already operating at 200mm and 300mm). This innovation is being led by IQE Plc and offers the potential to significantly grow the compound semiconductor market by establishing supply to large silicon foundries.

6. Does the UK have the required skills, talent and diversity to be able to boost its current semiconductor industry and to respond to future disruption?

6.1 Semiconductor manufacturing requires scientific, engineering and commercial talent. There is a strong talent base with these skills within the UK. It is critical that further investment is made in growing this talent pool to ensure the growing demand for skills can be met and that wage inflation does not make businesses uncompetitive in the global marketplace.

6.2 Achieving a scaled compound semiconductor industry with a national champion at its centre will reinforce the reputation and attractiveness of local universities with a focus on similar technologies. Global examples of this include the Boston area in the US and Grenoble in France. The compound semiconductor focus of Cardiff and Swansea Universities enables the same opportunity, both of which work closely with IQE Plc.

6.3 The diversity of the UK semiconductor industry needs to be improved. The industry has significant skills and experience within an ageing workforce, with a need to attract, retain and

develop younger talent. Within this, there is also a need to attract greater gender and ethnic diversity. Initiatives to attract more diverse talent to the industry via academic study and/or apprenticeships are critically important, as are initiatives that invest in skills development and ongoing learning. Such initiatives could include funding for increased STEM investment for school-aged children, grants for diverse candidates to study STEM subjects at University, training subsidies for science and engineering graduates and enhanced apprenticeship schemes targeted at diverse groups entering STEM careers.

7. What are the potential national security concerns or vulnerabilities in our semiconductor industry? How should the UK collaborate with the United States and European Union? What are the ramifications on other industries and the wider economy within the UK?

7.1 The key vulnerability relates to access to technology. Countries with no influence in semiconductor supply chains are most likely to suffer from shortages of product due to supply chain constraint or geo-politics. A strategic foothold in the semiconductor industry would reduce this vulnerability for the UK.

7.2 The escalating cost of energy in the UK represents a key vulnerability for the UK in the attraction and retention of commercial investment in semiconductor manufacturing. Competing nations do not all have the same cost dynamics. Targeted Government energy subsidies would represent an opportunity to maintain the competitiveness of the UK semiconductor manufacturing industry.

7.3 Many industries are becoming increasingly reliant on technology, including the defence and security industry. Advanced military technologies are increasingly reliant on compound semiconductors for sensing and connectivity applications. The UK has an opportunity to lead in these technologies with its compound semiconductor industry.

7.4 European (including UK) semiconductor companies have an opportunity to target the global marketplace and be neutral to the forces that are resulting in a decoupling of US and Asian technology supply chains. Where products are not subject to national security restrictions or concerns, this provides a source of competitive advantage for UK and European companies. By maintaining a neutral stance on the sale of UK semiconductor technologies globally and by investing in the competitiveness of the UK semiconductor industry, the UK has an opportunity to play an influential role in global supply chains.

8. Is the Government currently providing the clarity and direction required to enable growth and security in the semiconductor industry? Are the right governmental organisations involved with ensuring effective development of our current semiconductor industry to thrive in the future?

8.1 IQE welcomes the interest in the semiconductor industry and is a supporter of the UK developing a powerful and focussed semiconductor strategy.

8.2 Cross-Government and cross-industry dialogue, engagement and collaboration is critical to developing and executing this strategy. Semiconductors affect many aspects of Government and industry.