Written submission from Paragraf (SEM0079)

BEIS PARLIMENTARY COMMITTEE ON THE CURRENT STATE OF THE UK SEMICONDUCTOR INDUSTRY

The below responses to the questions posed by BEIS in the exercise of understanding the current state of the UK semiconductor industry are submitted by Paragraf. The company, and CEO S.Thomas individually, have responded to this call through several other channels/bodies, the below are therefore further comments ancillary to those other contributions.

The comments come from the context of a growing/scaling business founded in the UK, built on IP generated here in the UK.

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. Semiconductor materials and products are now the cornerstone of most electronic devices, products and technologies. The market for semiconductor electronics is growing at a rapid and steady rate, currently approaching ~$1trn and will continue this trend pulled by the maturation of new technology spaces such as EV's and IoT. Today the largest proportion of 'common product' semiconductor components are manufactured in Asia where very expensive capital infrastructure has been assembled over many years along with the knowledge and capabilities to efficiently and cost effectively mass produce chips.

2. When discussing the semiconductor materials demand there has to be consideration of the different types of semiconductors, namely Silicon, Compound and Advanced semiconductor materials. Today Silicon is by far the most consumed material product class, considered very mature from a material and electronics architecture perspective. Silicon technologies is a very well-established mega-industry located largely in Asia.

3. Although 25+ years old, with established technology classes the Compound Semiconductor device industry is still considered a developing semiconductor class, in many spheres now offering technologies with better performance parameters than the incumbent silicon devices, however, not as cost effectively. While the Compound Semiconductor high volume manufacturing field lies mainly in Asia and the US, the UK does have capability and knowledge in this area both at a materials level and technologies built from these materials perspectives. Demand for compound semiconductor materials in common products will grow significantly in the UK and globally over the coming years.

4. Advanced semiconductor materials (graphene, silicon carbide, diamond and transition metal dichalcogenides) electronics devices are currently at a very early stage with first products just entering the market. There is no established regional demand for these materials in 'common products' yet however heavy investment is going into these areas globally, including in the UK. These materials offer transformative change to the electronics industry and future demand is expected to be exponential in growth over the next 10 years, across the globe.

What is the UK's semiconductor supply chain and is this secure?
If not, how can this be improved?

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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?

5. The UK is a very (very) small player in the Silicon semiconductor materials and products world, is a little more important in the compound semiconductor supply chain and is leading the way in the advanced semiconductor sphere. Supply chains in the UK are stretched with several links missing at critical points, outsourced semiconductor assembly and test (OSAT's) being one example of this, volume packaging another. Most semiconductor containing end product from the UK requires some level of overseas service making the security of the final device supply chain questionable. Historical capabilities that were in the UK have been eroded resulting in the UK falling back meaning the UK can't now be compared with China, South Korea, the US and some European countries in terms of both capability and scale.

6. While there are some fabs in the UK, Newport Wafer Fab, currently subject to a government investigation into its recent acquisition, Nexperia and II-VI are foreign owned supplying into their global demands there is no real focus on the UK supply chain from these entities. However, the time for serious investment into Silicon and to some extent compound semiconductor product capabilities, to rival other parts of the world, has passed. The cost, time, effort and resource to do this would be monumental and the probability of 'catching' the large incumbents low.

7. However, in the UK there are many great semiconductor product companies, they tend to be in the niche product areas where innovation and next generation technologies allow a value sell capable of sustaining and growing those businesses. Chip design is one such area with successes such as Arm and Graphcore being great examples, similarly targeted applications of materials such as optoelectronics or compound semiconductor discrete components have been highly successful.

8. Equally great innovation in the UK has resulted in a leading position in advanced semiconductors, targeting these areas of strength and the future of semiconductor products, as opposed to trying to level up to the capabilities of the rest of the world in well established fields, could potentially make the UK an incredibly important, and highly valuable, part of the future global supply chain.

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?

9. The greatest opportunity for strengthening the UK semiconductor industry is the support of new innovations, to help them get off the ground, become established in the UK and importantly derive value here in the UK. Innovation resulting in transformational tech is our greatest strength here in the UK. UK inventions have reshaped semiconductor technology fields in the past and it can do so again, quite readily with the right strategy.

10. The UK already has some great institutions that can help drive this, the CPI, the CSC, the Advanced Photonics Institute, the III-V Centre to name a few. However, focus in the UK remains on early stage, low TRL technology support to get the ideas off the ground which fades away sharply when businesses look to establish their products and scale. There are

countless examples of great UK innovations delivering incredible returns outside the UK where conditions are more favourable for success. This is not a semiconductor industry problem alone, but it is a big one for this industry.

11. In conjunction this would also mean supporting the growth of supply chain ecosystems within the UK, enabling and helping businesses around the different links in the chain to be successful. A great example of this is device packaging, something the UK led many years ago but is now lagging significantly. However, there are some willing, capable new businesses that can address this deficiency, if they were better supported.

12. The 2 biggest weaknesses in the UK are (1) capital support, financing a capital intensive industry, which the semiconductor industry is, is extremely challenging here. Direct financing or relief mechanisms would go a long way to increasing the probability of success, reducing the number of technologies/companies that migrate. (2) Interconnectedness of potential supply chain partners, the semiconductor landscape here in the UK is very fragmented. Connecting businesses to co-operatively work for mutual benefit, allowing supply chains to be developed is very difficult. There are some good agencies, for example TechWorks and the NMI but if we're serious about the semiconductor industry in the UK efforts are required to develop the supply chains – connecting likeminded companies is the first step. Note, most semiconductor electronics businesses in the UK are too busy trying to survive and grow to be spending significant resource on finding, for example, a piloting test house here in the UK when a quick google search points them to a cost-effective solution in Malaysia or Taiwan.

13. This is an even more difficult task at the advanced materials end of the semiconductor world where highly capable partners, with flexible approaches are required to help with the new product development journey.

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?

14. Most product supply chains that utilise semiconductor materials or devices in the UK are not end to end, relying on at least some of the chain requirements to come from overseas, whether this is other components required for the product assemblies, for example packaging, or services that enable products to be built or tested. This has created many potential opportunities in many areas.

15. However, the success of UK semiconductor products traditionally lies in the niche, innovative, new technology spaces, for example high power/high frequency electronics, where our core strengths in science and engineering drive NPD. This offers huge opportunity as these products are usually high value and typically much lower volume than traditional consumer electronics meaning there are very good economic cases and, importantly, building the supply chain infrastructure to become end to end is much less capital intensive and realistically achievable. Typical gaps are, again in packaging – where the CSA now offers great design and consulting services thus adding manufacturing capacity and expertise should be relatively straightforward, and specialist, scalable test services which today often lie in academic institutes or R&D centres not geared for commercial exploit. Compound semiconductors are the main driver for products in this area, like Silicon this has become a much more competitive landscape in the past few years. If the UK can't increase its impact in

the near term in compound semiconductors, then it will go the same way as Silicon product manufacturing and be largely out of reach due to the economies of scale that will be available in Asia.

16. Consequently, the largest and clearest opportunity therefore is the creation of an advanced semiconductor supply chain in the UK. Materials such as graphene have been pioneered in the UK, the expertise currently lies here and with focussed investment the country could become the dominating force in electronic product manufacturing in this arena. Currently advanced semiconductor electronic products are very few, but those that have been achieved are extremely high value making the achievement of early end to end sovereign supply chains relatively cheap, economically highly attractive and comparatively very rapid in returning value. There is no value in trying to compete with Asia on established technologies however, the UK could become the global centre of the next era of semiconductor electronics with the right strategy.

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?

17. It is important to remember that research and innovation isn't limited to the early invention of materials or products. Invention, highly valuable knowledge and capabilities are built throughout the supply chain when creating a product or device. In semiconductors the IP 'stack' required to achieve a complete device is where the value lies. Focus on delivering the end product, TRL 8 and above, is absolutely critical if the UK is serious about its semiconductor strategy.

18. The UK is particularly weak in the pilot stages of product development and roll-out. Taking the small number of prototypes into volume, scalable, cost effective, reproducible, high-quality products generally relies on overseas infrastructure to achieve. With the potential sale of Newport Wafer fab into a foreign supply chain this becomes even weaker. The public facilities, such as the CSA, the CPI and the GEIC are going someway to address this issue but it is far too little, they are not commercial enough and are not cost effective. The strategy needs to be able to demonstrate and support clear pathways to cost effective product delivery, material through to end product and then address the gaps in the chain of that strategy.

19. Industry engagement is the key point here, with the shift in global politics over the past couple of years, the CHIPS Act in the US and similar expansion programmes across Asia and Europe it has never been more attractive to move a high-tech business from the UK. The migration of research and innovation knowledge away from the UK before achieving commercial success could end all competitive opportunities for the country in the semiconductor industry.

20. Communication within the UK semiconductor ecosystem is getting better, through the efforts of institution such as the NMI, or privately funded groups such as the Bessemer Society. In general however, this relies on word of mouth networking to achieve effective partnerships which is far from ideal. Sponsored forums, with real visionary intent behind

them, or ‘serious’ trade and industry events and conferences could go a long way to address this.