

A Brief Analysis of Worldwide Patent Filings Relating to Graphene by UK Resident Applicants and Inventors

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Introduction

Graphene is considered a nanomaterial as it consists of sheets of carbon atoms a single layer thick in a hexagonal arrangement [1]. The media refer to graphene as the “miracle material of the 21st Century” [2] and its public profile was boosted when the Nobel Prize in Physics 2010 was awarded to Andre Geim and Konstantin Novoselov of Manchester University “for groundbreaking experiments regarding the two-dimensional material graphene” [3].

On 3 October 2011, a year after Andre Geim and Konstantin Novoselov won the Nobel Prize in Physics, the UK government pledged £50m towards developing spin-off technologies from graphene [4]. The money will “give researchers more bench space to explore the material’s commercial potential” and “take this Nobel Prize-winning discovery

from the British laboratory to the British factory floor”.

This brief analysis gives an overview of the worldwide patent filings relating to graphene by UK resident applicants and inventors.

General Patenting Trends

Searching in the EPODOC and WPI patent databases in July 2011 yielded 3018 published patent documents relating to graphene; 46 of these documents (<2%) belong to UK-based applicants, and 75 belong to UK resident inventors (<2.5%). Figure 1 shows the top applicant countries and suggests that the UK is falling behind other high-tech nations such as the USA, Japan, Korea and Germany when it comes to research into graphene and its potential commercial applications.

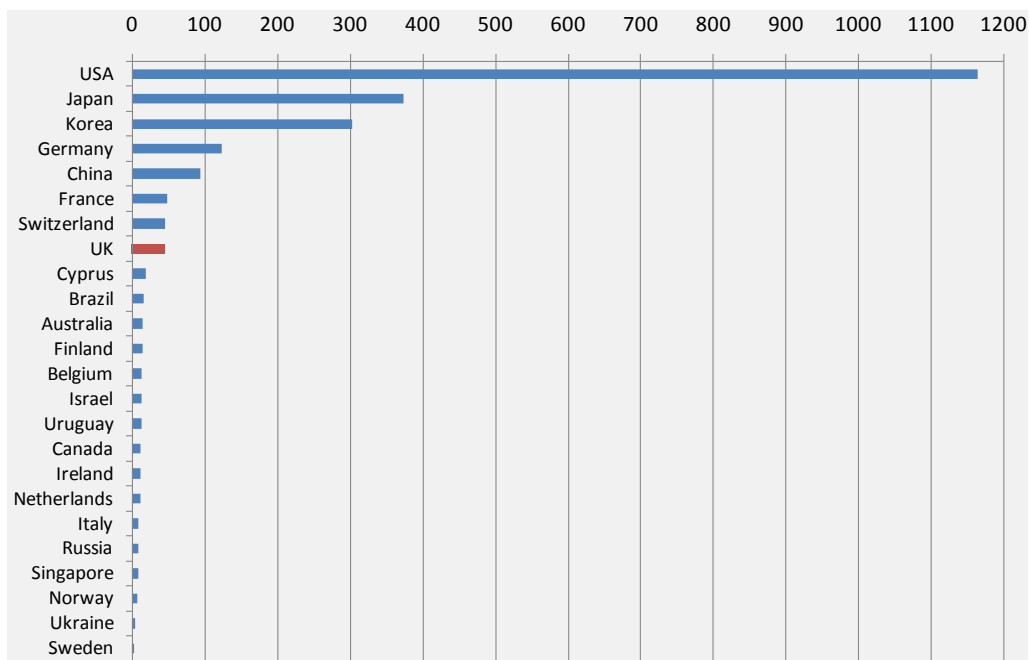


Figure 1: Top applicant countries

85% of the 46 documents by UK-based applicants have named UK resident inventors on the patent applications, but 58% of the 75 documents with named UK resident inventors are filed by international applicants. This suggests that many international research organisations are employing UK resident researchers to undertake their research into graphene, taking innovation and subsequent economic benefits away from the UK. This is backed-up by a speech by the Chancellor, George Osborne, in October 2011 where he said that “Countries like Singapore, Korea and America are luring researchers with lucrative offers to move their research overseas” [4].

The historical profile of patent publications worldwide (Figure 2) shows that there has been a rapid take-off of patenting related to graphene since 2000, but that the UK impact on this growth, in terms of UK-based applicants and UK resident inventors, is negligible.

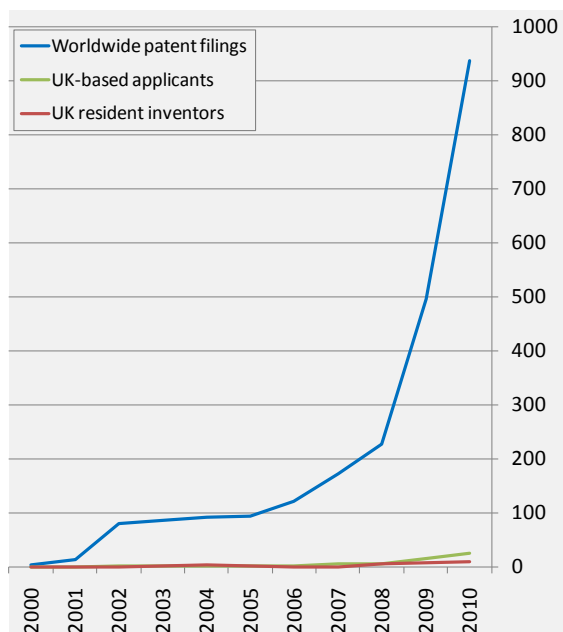


Figure 2: Historical filing profile by publication year

Applicant Trends

Figure 3 shows a direct comparison between the overall largest patent portfolios, with Samsung having a clear margin over Sandisk, against the patent portfolios of UK-based applicants (shown in detail in Figure 4). It is clear from Figure 3 that, at present, UK-based applicants do not compete with international

applicants. The top UK-based applicant, Hexcel Composites, has four patent families (19 published patent applications) and lies 83rd on the overall list of top graphene applicants. The joint 2nd top UK-based applicants, QinetiQ, IBM UK, and STREP (Science and Technology Research Partners) all have two patent families relating to graphene and fall outside the top 150 in the overall list of top graphene applicants. Only a single UK-based applicant in the top 150 worldwide further backs up the government’s view that research and innovation in graphene in the UK is lacking and needs an injection of cash as soon as possible.

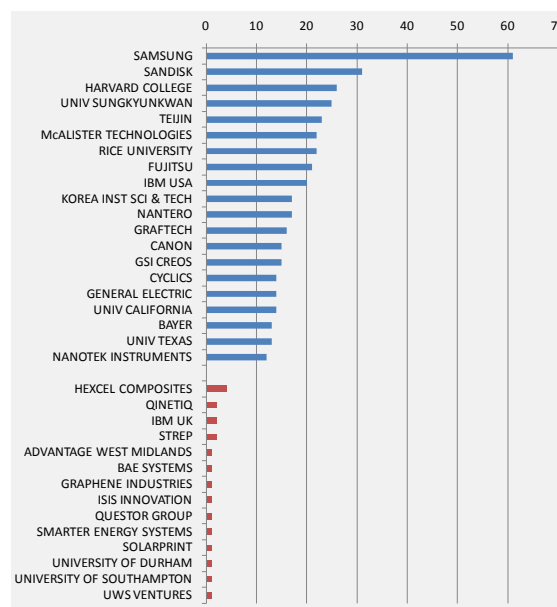


Figure 3: Comparison of the number of patent families of the top 20 applicants worldwide versus all UK-based applicants

Hexcel Composites are a large advanced material solutions company based in Cambridge with over 350 employees and an annual turnover of over £100m. They are currently involved with carbon research that includes new composite materials comprising graphene.

QinetiQ, a global defence technology company (formerly the Defence Evaluation and Research Agency, DERA) are joint applicants with Advantage West Midlands, a Regional Development Agency (RDA) who appear to have provided some funding to QinetiQ for this research, on one patent application relating to graphene-based semiconductors.

IBM UK appear to be working on self-aligned graphene field effect transistors. Graphene Industries are a small spin-out company based in Manchester to capitalise on the advances made by Professor Geim’s research group at the University of Manchester. They were the first commercial supplier of graphene in the quantities and formats required for micro- and nano-electronic fabrication and research. Their patent relates to graphene fabrication.

Four UK universities have published patent applications relating graphene - the University of Southampton collaborated with Harvard College in the USA on nanoscale wires; the University of Durham’s recent patent application relates to producing graphene from metal alkoxide; Isis Innovations, a wholly-owned subsidiary of the University of Oxford that manages their technology transfer, filed a patent application back in 2002 involving the purification of nanotubes at a temperature wherein only the graphene is oxidised; and UWS Ventures, a micro-company who manage the IP emerging from Swansea University and have a turnover of over £200k, have a single application relating to a graphene biosensor.

proportion of researchers listed as being resident in the UK are either doing their research abroad or doing their research for a non-UK company.

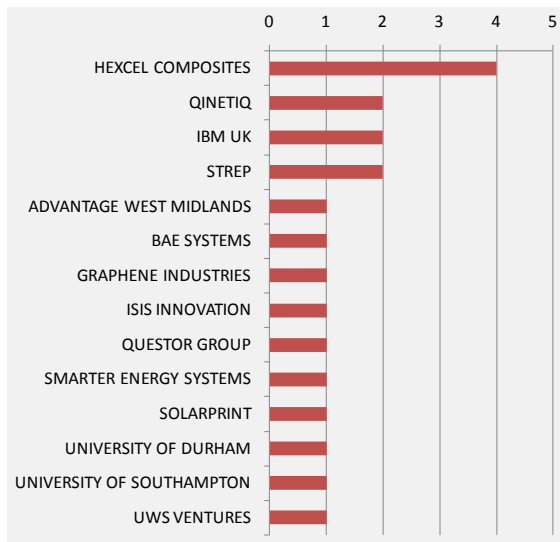


Figure 4: Number of patent families of UK-based applicants

Figure 5 shows the patent portfolio size for applicants with named UK resident inventors. The two largest portfolios are from Cyprus and US-based applicants, but only one UK-based applicant in the top 5 suggests that a large

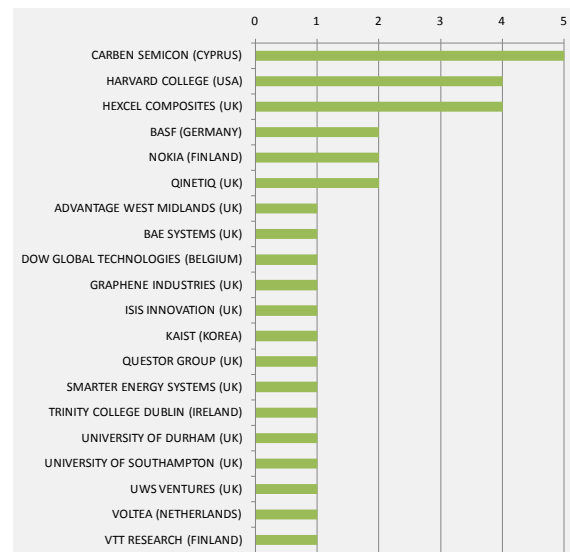


Figure 5: Number of patent families of applicants with named UK resident inventors

Figures 6 and 7 show the applicant timelines for UK resident applicants and inventors respectively. Both of these timelines show that, with the exception of some research universities, all of the UK innovation has taken place in the last couple of years. This suggests that graphene research in the UK has begun to gather some momentum since 2008, but the previous figures show that as a nation we are still some way behind the other major innovative countries around the world.

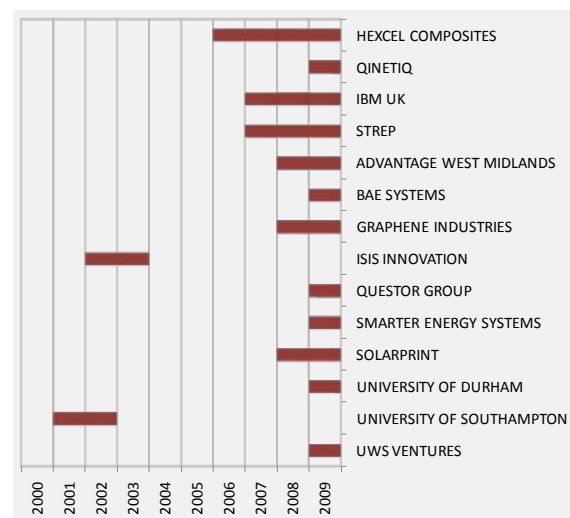


Figure 6: Applicant timeline by priority date for UK-based applicants

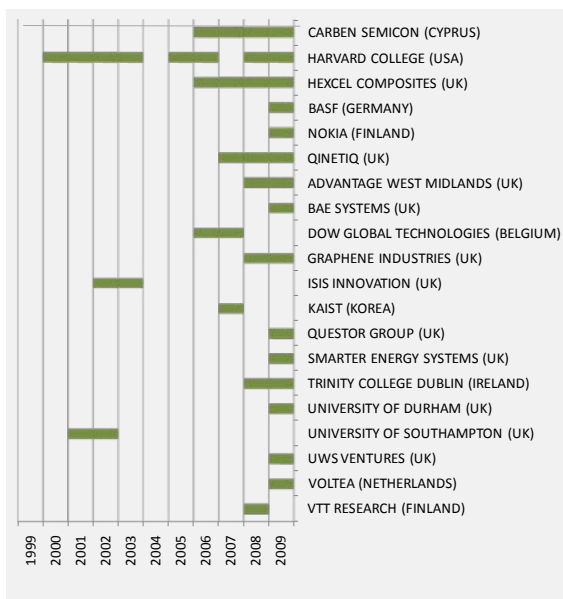


Figure 7: Applicant timeline by priority date for UK resident inventors

Applicant Collaboration

Figure 8 shows a collaboration map for UK-based applicants and their collaborators on patents relating to graphene. It highlights the international collaboration between the University of Southampton and Harvard College, and the RDA-funding provided by Advantage West Midlands to QinetiQ as mentioned previously.

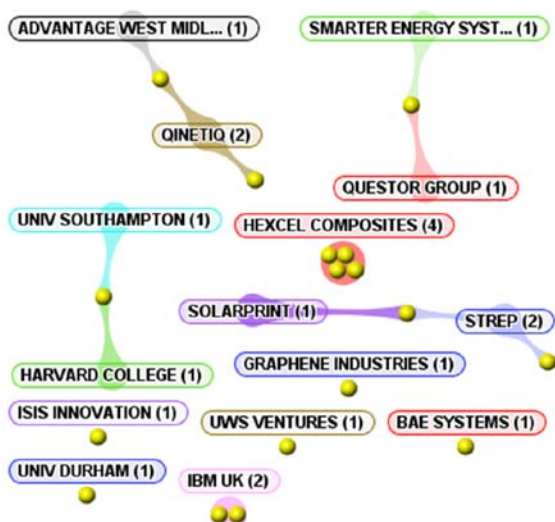


Figure 8: Collaboration map showing the collaborations made by UK-based applicants and their collaborators

Conclusion

This brief analysis comparing how the patent filings of UK resident applicants and inventors in the field of graphene compares against the worldwide patenting of graphene-related technologies shows that the UK has fallen some distance behind the other major innovative nations when it comes to graphene research.

The potential applications of graphene are widely publicised in the media and the benefits that a breakthrough commercial product could bring to a nation’s economy are likely to be substantial. It is therefore not surprising that the UK government has recognised this and pledged £50m in the near future to invest in graphene technology [4].

If the present patent filings are indicative of the level of research currently being undertaken in the UK then this funding is arriving at a crucial time. The government funding may also help to persuade academic researchers in graphene to stay in the UK to undertake their research, either in UK academia or in UK companies, instead of heading overseas to research institutions with higher levels of funding, thus helping UK innovation and keeping any future economic benefits within the UK.

References

[1] H.P. Boehm, R. Setton and E. Stumpp, “Nomenclature and terminology of graphite intercalation compounds (IUPAC Recommendations 1994)”, Pure Appl. Chem., 1994, Vol. 66, No. 9, pp. 1893-1901

[2] http://news.bbc.co.uk/1/hi/programmes/click_online/9491789.stm

[3] <http://www.nature.com/news/2010/101007/full/news.2010.525.html>

[4] <http://www.bbc.co.uk/news/science-environment-15152609>



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