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Global Expert Mission
Advanced Materials in Israel 2018

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Welcome

Innovate UK's global missions programme is one of its most important tools to support the UK's Industrial Strategy ambition for the UK to be the international partner of choice for science and innovation. Global collaborations are crucial in meeting the Industrial Strategy's Grand Challenges and will be further supported by the launch of a new International Research and Innovation Strategy.

Innovate UK's Global Expert Missions, led by Innovate UK's Knowledge Transfer Network, play an important role in building strategic partnerships, providing deep insight into the opportunities for UK innovation and shaping future programmes.

The Advanced Materials Expert Mission travelled to Israel in February 2018 and in this publication we share the information and insights gathered during the delegation's time in Israel.

1. Introduction

Advanced materials are vital to the UK manufacturing economy and its future. The materials manufacturing sector supply chain is important, but the dependence of all manufacturing sectors on materials is, arguably, even more significant. Key UK sectors, such as aerospace, automotive, construction, electronic equipment, energy, medical equipment, packaging, rail and their supply chains all need materials to deliver bulk and niche products. Furthermore, they need materials innovation to develop products suitable for future market requirements and applications, for example, light-weight and multi-functional materials.

Examples of advanced materials can be found in graphene-based products as well as 2D materials science, nanotechnology, liquid crystals, semiconductors, superconductors, optics, lasers, sensors, porous materials, light emitting materials, ceramics, biological materials, magnetic materials, thin films, colloids, energy materials, photovoltaics, solar cells, biomaterials, photonics, ferroelectrics, multiferroics, metamaterials, drug delivery, cancer therapy, tissue engineering, imaging, self-assembly, hierarchical materials, batteries, super-capacitors, thermos-electrics, polymers, nanomaterials, nanocomposites, nanotubes, nanowires, nanoparticles, carbon, diamond and fullerenes.

Bilateral trade between the UK and Israel reached a value of US$6.9 billion in 2017, and the UK is Israel's second largest trading partner. It is also Israel's number one destination for investment in Europe, with more than 300 Israeli companies operating in the UK.

The UK and Israel both have a strong background in advanced materials, stemming from top performing universities and industrial research and development. While Israel has particular expertise in nanotechnology and nanomaterials; the UK focuses more on the application of advanced materials.

Israel has historically been at the forefront of cutting-edge technology innovation due to the high proportion of GDP spending on research and development (4.46%), and the significant number of venture capital firms investing in the long-term development of new concepts and ideas. The Yozma programme[1], established in 1993, has been the catalyst for the Israeli venture capital industry. It provided early-stage funding that enabled Israeli companies to bring products to market quickly and with a lower degree of risk compared to their competitors. Yozma was the starting point of significant support for innovation, and it continues to operate today.

Israel proudly considers itself to be the "Start-up Nation" and positions itself at the forefront for developing entrepreneurs and start-ups. The internal market is small, so they seek export opportunities. As a nation, Israel seems happier to accept risks; there is no stigma attached to failure, only in not trying.

Israel's growth has been achieved through the support of high-tech industries – a sector that is characterised by a large number of innovative start-up companies developing pioneering components or technologies. These innovative solutions are often acquired by global enterprises, resulting in a relatively small number of new companies that continue to grow and establish entire value chains.

Israel's unique defence situation, associated government defence spending and compulsory national service, provide a platform to develop talent and technologies for military purposes which can be migrated to other sectors for further applications. Young people undertake two or three years of mandatory military service in which they create strong networks and develop an ability to think creatively. These networks extend beyond military service and contribute significantly to Israel's culture as an innovative start-up nation with a strong "can do" attitude. The effects of military service and the strong sense of community yielded by support for a common cause, are significant factors in Israel's ability to achieve what it has to date.

In advanced materials, many dual-use technologies, originally developed by the defence industry from the 1980s onward, have found their way into other industries and civilian applications. This has been facilitated by the movement of staff, notably scientists and engineers, and has become one of the key drivers of growth in the high technology sector in Israel since the 1990s.

[1] WWW.YOZMA.COM

A combination of all these factors has created an ecosystem that has enabled Israeli companies, especially SMEs, to develop new technologies in advanced materials and successfully commercialise them in the US, China, India and Africa. Furthermore, international collaboration has been a priority for the Israeli government with the main purpose being to promote Israeli entities' participation in R&D ventures and consortium-based innovation projects with other countries seeking to identify new market opportunities.

1.1 Expert Mission Stakeholder Engagement

Eight representatives from industry and academia supported by staff from Innovate UK, the Catapult Centre and the Knowledge Transfer Network, took part in the expert mission with the aim of discussing potential collaboration opportunities with academic, industrial and government representatives.

The mission visit programme consisted of meetings and a business collaboration workshop with representatives from government, academia and industry. A brief overview of the organisations met, are detailed below.

Israel Innovation Authority (IIA)

The Israel Innovation Authority (IIA)[2], responsible for the country's innovation policy, is an independent and impartial public entity that operates for the benefit of the Israeli innovation ecosystem and the economy as a whole. Its role is to nurture and develop innovation resources while creating and strengthening the infrastructure and framework needed to support the entire knowledge industry. It was formerly known as the Office of the Chief Scientist of the Ministry of Economy (MATIMOP).

Israel-Europe R&I Directorate (ISERD)

The Israeli Directorate for R&D[3] is an inter-ministerial body established by the Ministry of Economics, the Ministry of Science and Technology, the Planning and Budgeting Committee of the Council for Higher Education, and the Ministry of Finance and Foreign Affairs. ISERD is part of the Israeli R&D Directorate for the European Research Area.

Israel National Nanotechnology Initiative (INNI/Nano Israel)

The mission of INNI (Israel National Nanotechnology Initiative[4]), is to ensure Israel's next wave of successful industrial development is in nanotechnology by creating an engine for global leadership. A primary task for INNI is to promote fruitful collaboration between Israeli and global nanotechnology stakeholders, and specifically to encourage projects that will lead to continuing success in academia and industry.

Technion University: Israel Institute of Technology

Technion (Israel Institute of Technology[5]) as well as being Israel's first university, is consistently ranked among the world's top science and technology research universities. Since its founding in 1912, the institute has educated generations of engineers, architects, and scientists who have played a key role in developing Israel's infrastructure and establishing its crucial high-tech industries.

Technion has been Israel's primary source of technological manpower and the nation's largest comprehensive academic centre for advanced science and technology education, as well as applied research. Also, Technion is one of only a handful of technology institutes in the world with an affiliated medical school.

Technion has 18 academic departments in engineering, natural sciences, medicine and architecture, as well as 60 research centres. Graduates make up the majority of Israeli-educated scientists and engineers, constituting more than 70% of the country's founders and managers of high-tech industries. They have founded and/or lead two-thirds of Israeli companies on NASDAQ.

Technion's success in supporting Israel's economy has been dramatic. Israel is now home to the highest concentration of high-tech start-ups anywhere outside of Silicon Valley. High-tech industry accounts for more than 54% of Israel's industrial exports, and over 26% of the country's exports. In Israel, 135 out of 10,000 workers are scientists and engineers, compared to the United States where the number is significantly lower at 85 out of 10,000. Moreover, in Israel, 9 out of 1,000 workers are engaged in R&D; nearly double the rate of the USA and Japan.

The Hebrew University of Jerusalem

The Hebrew University of Jerusalem[6], founded in 1918 and opened officially in 1925, is Israel's leading university and research institution. It is ranked internationally among the top 100 universities in the world and first among Israeli universities.

The Hebrew University holds more than 9,000 patents and is credited with 2,753 inventions, an average of 150-per-year. One hundred and twenty spinout companies, 600 commercial products and over 800 licenses ensure that the university benefits from significant annual revenues, enabling investment in education and research.

[2] www.matimop.org.il
[3] www.iserd.org.il
[4] www.nanoisrael.org
[5] www.technion.ac.il
[6] new.huji.ac.il
[7] www.earlysense.com

EarlySense

Founded in 2004, EarlySense[7] focuses on innovative continuous patient monitoring systems designed to enhance patient safety and reduce the risk for general care patients for hospitals, healthcare systems, integrated delivery networks and rehabilitation centres. With real-time delivery of actionable data, together with patient management tools, its remote sensing system provides continuous monitoring of a patient's heart rate, respiratory rate and motion, to potentially allow the clinical team to manage:

- early detection of patient deterioration
- fall prevention
- pressure ulcers prevention.

Tortech Nano-Fibers

Tortech Nano-Fibers (Tortech)[8] was founded in 2010 as a joint venture between Plasan Sasa Ltd (Israel) and Q-Flo Ltd (UK), a spinout from Cambridge University.

Tortech is developing and industrialising a patented process for the manufacture of ultra-long Non-Woven CNT mats for a wide range of commercial applications. The facility is at pilot plant maturity, and the organisation is seeking to increase output volumes and to produce larger dimensioned mats, CNT yarns and ropes. Tortech is a member of the ANAM (Advanced Nanotube Application & Manufacturing) Initiative, an EPSRC-funded project involving the University of Cambridge, the University of Ulster and industrial partners, including Siemens, Magna Industrial, BAE Systems, Marshall Aero & Defence and Tortech. Research areas include thermal, electrical, and structural materials, as well as energy storage, batteries and scale-up for high throughput production volumes.

Taglit Innovation Centre

Taglit-Birthright Israel built the "State of Mind" Taglit Innovation Centre[9] in partnership with The Tel-Aviv Stock Exchange. The Innovation Centre allows visitors to learn about advancements being made by start-ups in fields such as science, medicine, security and space. Visitors to the centre first explore the interactive exhibition and then have a one-on-one meet up with a leading Israeli entrepreneur.

[8] www.tortechnano.com
[9] www.taglitinnovation.com

2. Advanced Materials in Israel

2.1 Historical Perspective

Over the past forty years Israel has invested heavily in the development of programmes aimed at improving national R&D capabilities to a point that could be considered world class. Israel is now recognised as a global leader in research and innovation. The percentage of GDP spent on civilian R&D expenditure is one of the highest in the world, with the only competing nation being Korea (>4%). Figure 1 shows trends in civilian R&D expenditure over a ten-year period.

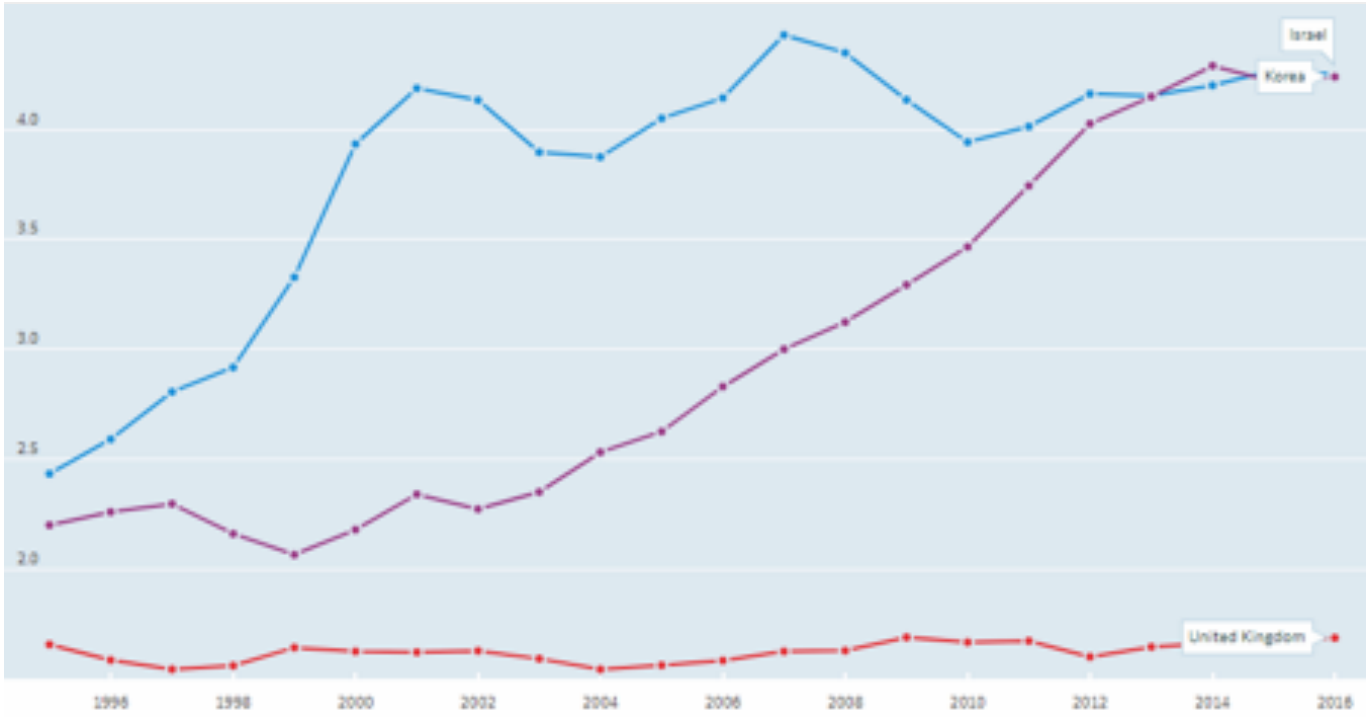
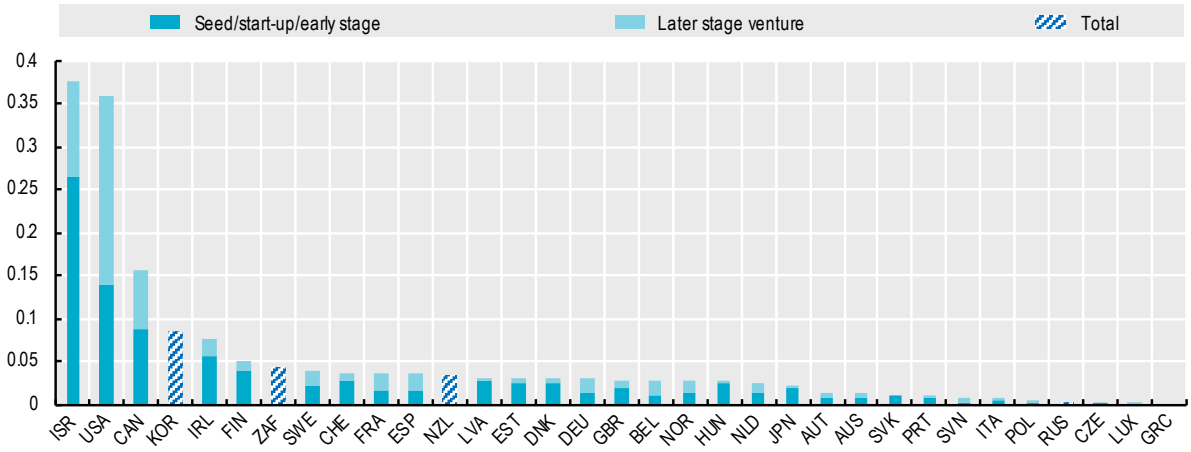


Figure1: Civilian R&D expenditure as a percentage of GDP
Comparison between Israel and the UK

Research and development investment jumped significantly in the 1990s when Israel recognised the increasing use of technology and the need for fast-developing innovative solutions. In response, Israel developed programmes to encourage venture capital investment (for example, the Yozma programme) and to attract talent to relocate or return to Israel.

In Israel, 90% of investment into R&D came from private sources with the remaining 10% coming from the government. Venture capitalists have invested heavily in IT and high-tech sectors and continue to do so in areas such as augmented and virtual reality, and cyber security. The impact this has had on the Israeli economy is shown in the following statistic: the Israeli Innovation Authority estimates that the high-tech sector, employing only 10% of the country's workforce which contributes a total of 15% to national GDP, produces 50% of all industrial exports. Other more traditional sectors such as materials and pharma do not attract the same level of venture capital investment and are consequently supported via government programmes and initiatives. Figure 2 demonstrates venture capital investment, per country, as a percentage of GDP during 2016.

Figure 2: Venture capital investment as a percentage of GDP
Percentage, 2016, or latest available year



2.2 Policy Drivers and Stimuli

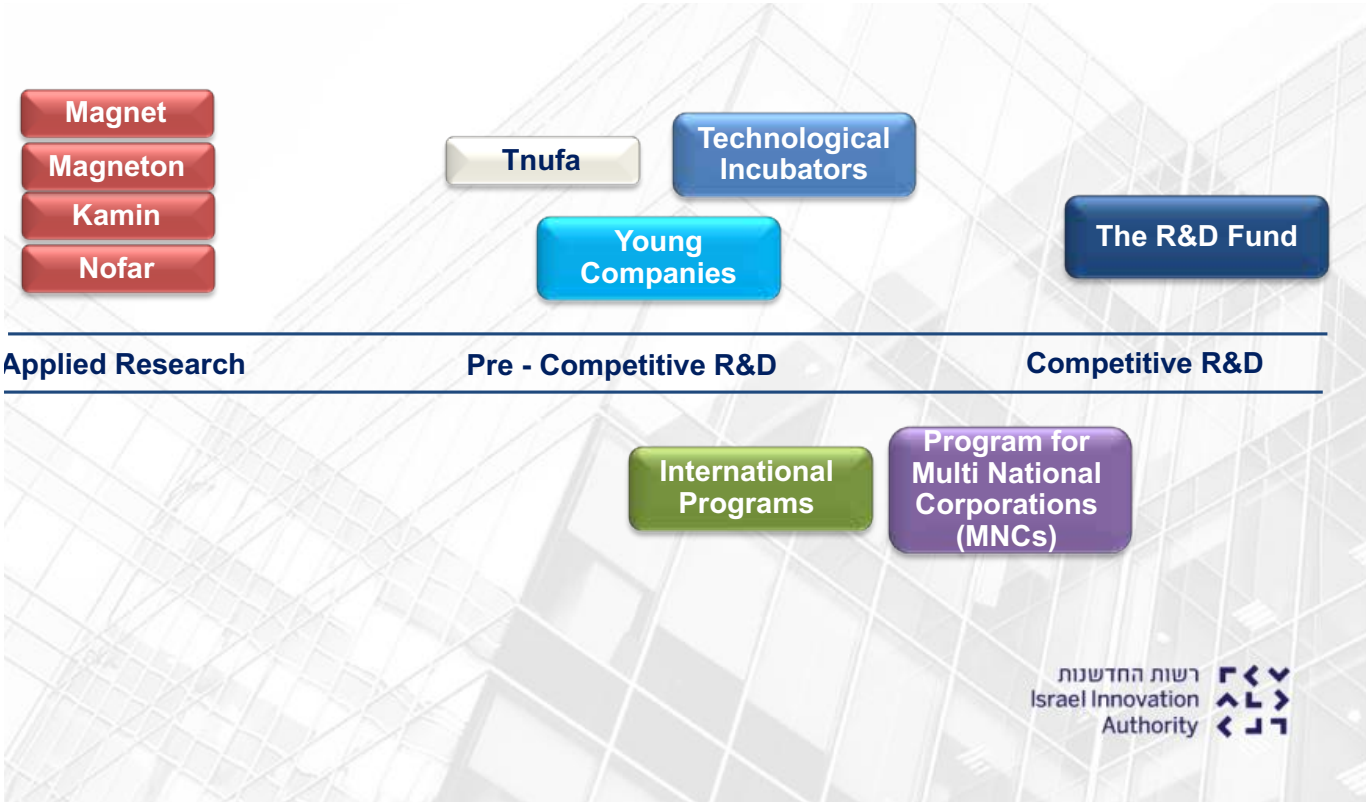
Public sector funding for R&D is the responsibility of the Israel Innovation Authority (IIA). Several complementary programmes offering support for different stages of research are delivered nationally. In 2016 the budget for all programmes was approximately US$400 million.

The Technological Infrastructure Division of the IIA focuses on collaboration between industry and academia to produce advanced technologies and innovative products. The incentive programmes offered by this division promote cooperation, exchange of knowledge and experience, and the development of ground-breaking knowledge by a group of researchers from academia and industry. They seek to strengthen the long-term technological advantages of Israeli industry in the face of fierce international competition. The target audiences are:

- University researchers interested in transforming their discoveries into products.
- Academic research institutions looking for new and practical research directions for industry.
- Industrial corporations interested in developing innovative products.

There are eight programmes offering support to academia and industry. Figure 3 presents the programmes currently available to support R&D in Israel.

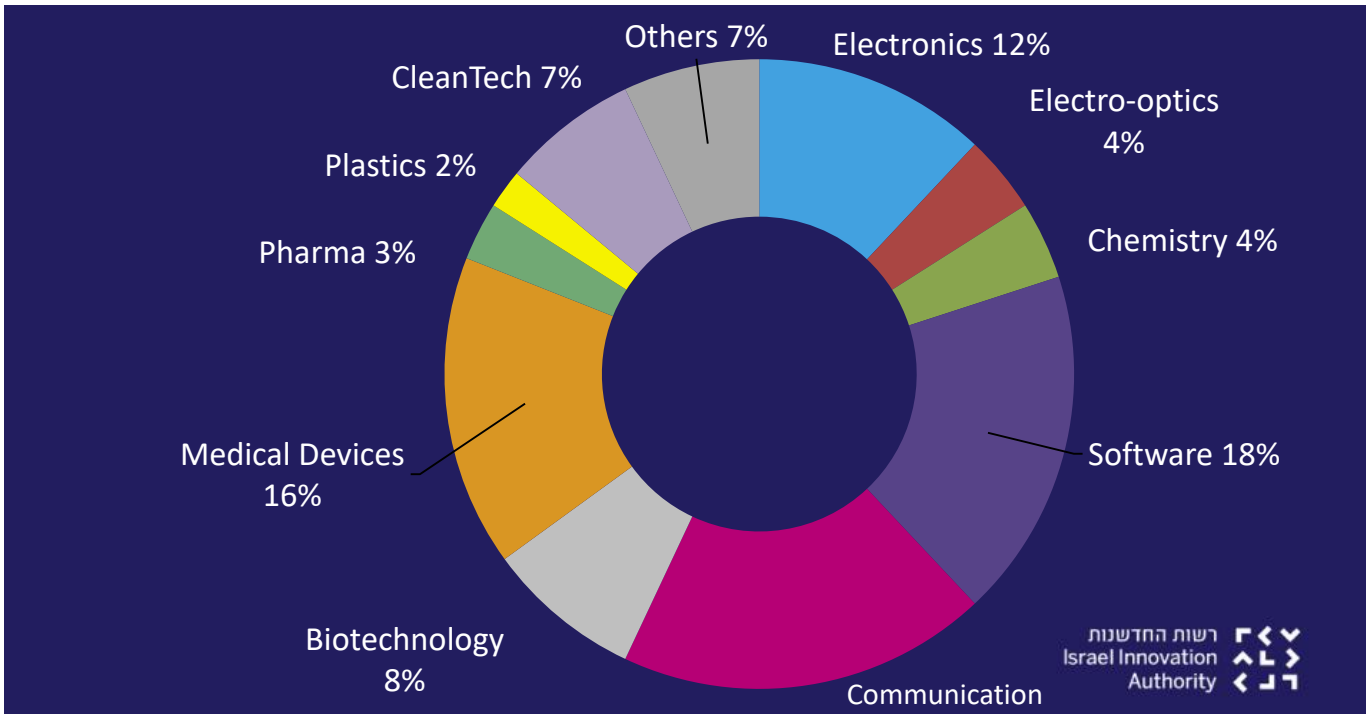
Figure 3: IIA R&D funding programmes



The programmes most relevant to advanced materials R&D are Magnet, Magneton, Kamin and Nofar. See Annex 2 for a description of the programmes.

Grants are not limited to specific sectors and applications are received from a wide variety of businesses. Advanced materials R&D occurs across many areas of the technology sector but is not explicitly reported. There is a rigorous evaluation process for applicants, and grant funding must be supported with a match funding of 20% to 50% from private sources. Programmes are managed on a performance basis and those that are not performing lose funding. Figure 4 demonstrates the breakdown of grants awarded by industry sector.

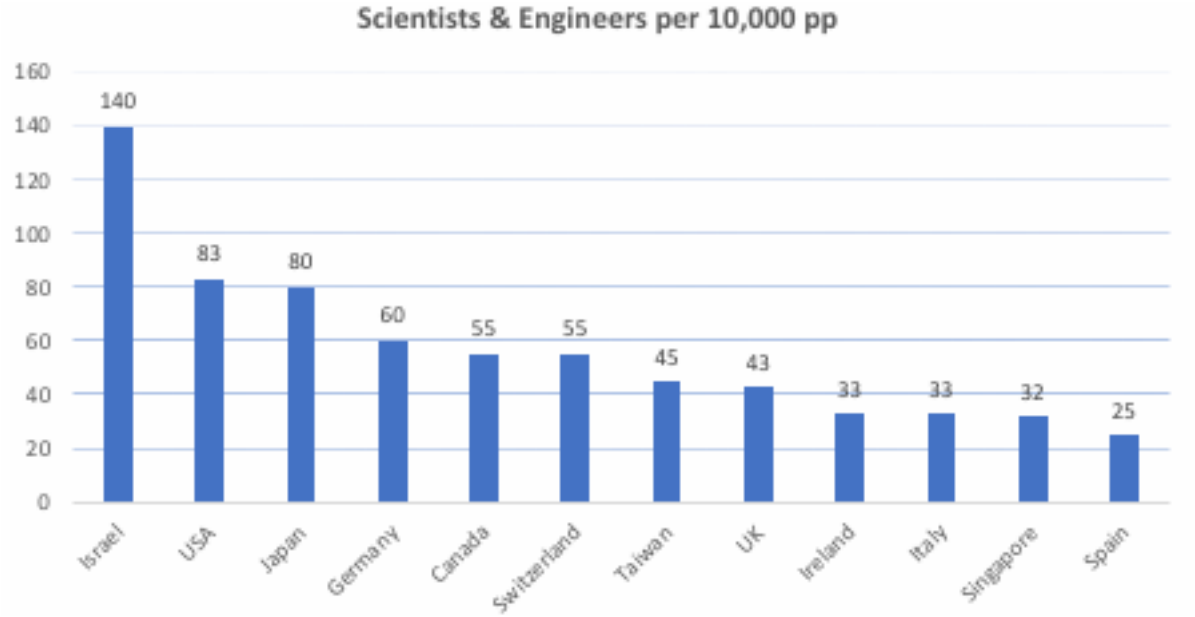
Figure 4: IIA grants by technological sectors in 2015.



Grants are converted to loans upon the successful completion of programmes with repayment, based on LIBOR rates, commencing once the funded programmes start to achieve a return on sales. The income from loan repayments is re-invested into grant programmes and makes up approximately 30% of the annual budget. Intellectual property is expected to remain within Israel, and if it is transferred out of the country, then fines are levied on the participating organisation.

In addition to the significant levels of public and private investment in R&D, another important factor promoting advancement is the pool of talent that Israel has available. Per head of population, Israel has the highest number of scientists and engineers of any country. Talent and ability are considered to be a major natural resource in Israel, and the identification and development of gifted children has been an area of national priority for many years. The Department of Gifted and Outstanding Students[10], part of the Ministry of Education, runs a national Special Giftedness programme that identifies gifted and talented children. Tests are conducted at second grade to help identify the top 15% of talented pupils who are then enrolled in a programme of excellence. A significant influx of talent from Russia occurred in the 1990s, and Israel has actively encouraged Jewish academics to locate to the country with attractive R&D support packages.

Figure 5: represents the number of scientists and engineers per 10,000 of population in the world's key industrial countries.



Source: Israel National Nanotechnology Initiative

Israel adopted a policy of incentivising academic talent to locate or re-locate back to Israel. High-performing academics were targeted and offered significant research resources. One hundred million dollars was invested in research facilities that attracted around 120 PhDs who are delivering R&D programmes in all of Israel's universities. This clustering of academic R&D attracts global organisations seeking to access cutting-edge research and has resulted in over 300 organisations establishing R&D facilities in Israel.

The stated mission of the IIA is: Achieving economic prosperity through technical innovation by:

- Maintaining a globally competitive knowledge-based industry.
- Improving the productivity of the entire private sector through technological innovation.
- Improving the effectiveness and quality of public services through technological innovation.

Much of Israel's success has been in the high-tech and ICT sectors. The Israeli Innovation Policy for the past twenty years has been to create an innovation-driven industry; this is referred to within the IIA as the Start Up phase. Policy for the next twenty years is focused on the next phase, referred to as the Scale Up phase, the mission of which is to ensure Israel remains at the forefront of global innovation performance whilst improving on the capabilities of all other sectors, including advanced materials, to be as competitive as the Israeli high-tech sector.

[10] edu.gov.il/minhalpedagogy/gifted

2.3 International Collaboration

The IIA also offers a variety of international cooperation and incentive programmes operated by the International Collaboration Division desks.[11] A recent example of a successful UK-Israel technological collaboration is the National Health Service (NHS), through the National Institute for Health Research[12], which has formed strong collaborations with Israeli life sciences companies conducting clinical trials in the UK.

Programmes include Horizon 2020[13] EUREKA[14] bilateral R&D co-operation programme of collaboration with many countries including the UK and The European Global Navigation Satellite System[15] (GNSS). Full details of all programmes are available from the Israel-Europe R&D Directorate[16] (ISERD).

Together with its counterpart organisations overseas, the International Collaboration Division (ICD) defines the objectives of the programmes and the criteria specific to each incentive programme, publishes calls for proposals, assists in finding partners for projects, and coordinates the evaluation of projects and their approval on both sides. Moreover, the division's desks help with matching between partners in Israel and abroad to create joint R&D projects, organising meetings between Israeli and international companies and investors, and facilitating participation in conferences, exhibitions and more.

Other parts of the IIA benefit from the array of programmes, tools and international connections available through the ICD, which acts as a bridge between economies and business cultures. The division's activities are directed at both Israeli and international clients. Target audiences are:

- International clients: R&D companies, multinational corporations, overseas investors, etc.
- Israeli clients: Companies, as well as academic and research institutes that are looking for comprehensive assistance in penetrating international markets.
- Overseas governments and foreign funding agencies seeking to establish cooperation agreements with the Israeli government (on whose behalf the IIA operates).

It was apparent from discussions at both Technion and the Hebrew University that there is an appetite for further collaboration within the advanced materials sector with industry and academia in the UK. Opinions expressed by Israeli presenters indicated that while meetings and visits have taken place in the past, little actual progress has been made with respect to actual collaborative programmes of work.

2.4 Advanced Materials R&D in Israel

As part of Israel's transformation from Start Up phase to Scale Up phase, the Israeli government has recognised the importance of nanotechnology and has launched the Israel National Nanotechnology Initiative (INNI), which sets national goals and priorities for advancing nanotechnology.

For Israel to become an important global player in advanced materials, nanotechnology, and its applications, it recognises that it must formulate long-term programmes for research and technological development, create world-class infrastructure, provide leadership and promote collaboration between academia and industry.

Over the past ten years, INNI has stated that Israel has progressed from a position of low involvement to fourth in the world for nanotechnology R&D. Six of Israel's eight universities have programmes, funded by INNI, in nanoscience and/or nanotechnologies and in the past nine years, they have launched 55 start-up companies, around 25% of which are expected to become commercially successful. The programme started by attracting talent to Israeli academic institutes and supporting them with infrastructure and funding to enable the development of research programmes of value to industry both in Israel and globally. Initial funding of the INNI programme for five years was extended to a further five years. Focus then changed from implementing a programme designed to build applied nanoscience infrastructure for academia and industry, to developing R&D programmes that could be applied to industrial applications within a reasonable timeframe.

The INNI programme is successful enough to be used as a template that is being applied to other industrial sectors. Some of the key achievements from the INNI programme in the last ten years include:

- 1,250 researchers and 150 faculty members involved in world-class research.
- 1,660 co-operations between academia and local or international industry groups.
- 1,590 patent applications submitted, 769 patents already approved.
- Over 12,000 published scientific articles.
- A national database for nanotechnology has been developed.

[11] www.iserd.org.il
[12] www.nihr.ac.uk
[13] ec.europa.eu/programmes/horizon2020
[14] www.eurekanetwork.org
[15] egnos-portal.gsa.europa.eu
[16] www.iserd.org.il

2.5 R&D in Universities

Universities are recognised as key to the country's ability to compete globally in all technology markets. There are nine universities in Israel. Most of the country's basic research, across many fields, is undertaken within the universities. Research and development expenditure as a percentage of GDP and citations-per-academic publication are among the highest in the world. As part of the mission, meetings were held at Technion and the Hebrew University. At both meetings, academics presented some of the key areas of advanced materials research.

A clear desire for collaborative work with the UK was expressed, primarily driven by the potential for accessing additional funding and other markets. The mission experts representing UK universities identified that there are areas of advanced materials research where collaboration with Israel would be mutually beneficial.

At Technion, R&D into the use of carbon nanotubes as a current collector could be of interest to teams working on battery development. Furthermore, niobium nitride (NbN) superconductor R&D may be of interest to the Centre for Applied Superconductivity. The use of UK-manufactured graphene for the development of flexible batteries was also identified as a potential area of collaboration.

At the Hebrew University nanoparticle sensor development and the use of nanoparticles to apply colour to nanorods, were areas where further bilateral collaboration could be considered. There was also a potential opportunity to use UK-manufactured graphene as a replacement for Indium Tin Oxide (ITO) and as an electrochemical membrane.

2.5.1 Focal Technology Areas (FTAs)

The Israeli government has identified Focal Technology Areas[17] (FTAs) that constitute a cornerstone of present nanoscience and technology programmes. By directing funds to the identified FTAs, they have strategically determined what will be the key areas of research, technology transfer and commercialisation for universities. FTAs are defined by several criteria:

1. Generates world-class science and technological-industrial impact/interest.
2. Potential industrial impact in areas of interest/relevance to industry, present or future.
3. Mission-oriented.
4. Broad enough to include several research groups and achieve a critical mass of activity.
5. Intercampus and industry collaboration is valued.
6. The academic institutions must commit to a 200% match of all allocated funds.

There are seven FTA programmes running that are developing the materials needed to deliver functionalities for seven different areas:

1. Nanostructured Oxides for Quantum Conversion of Solar Energy – Low-cost, high-efficiency solar conversion, self-window cleaning and light management: Bar Ilan University.
2. Bio-Inspired Nano-Carriers for Sub-Cellular Targeted Therapeutics: Ben Gurion University.
3. Integrated Infrared Up-Conversion Imaging Device using Nano-Plasmonic Materials and Nano-Photonic Structures: Ben Gurion University.
4. Functional Coatings and Printed Devices: the Hebrew University.
5. Nano-Photonic Assisted Advanced Functional Detectors and Imagers: Technion.
6. Nanomedicines for Personalised Theranostics: Tel Aviv University.
7. Inorganic nanotubes (INT) – from nanomechanics to improved nanocomposites: The Weizmann Institute of Science.

By focusing research centres on solving specific FTAs, it brings together faculties, research and knowledge; thereby enabling a multi-disciplinary approach to research and advancing the development of new advanced materials.

[17] www.nanoisrael.org/category.aspx?id=31648

2.6 Technology Transfer

Technology transfer is at a mature stage and is recognised as an important business development tool for universities that includes technology platform development, long-term industry-university collaboration, education and training. Each university employs significant technology transfer resources to maximise income and opportunities. Technology transfer teams take a proactive role of pushing research and information into industry so that collaboration and licensing opportunities can be realised.

Within the universities, the technology transfer teams operate as stand-alone businesses tasked with objectives for the creation of business growth and income. Responsibilities include analysis of new inventions and concepts, protection and maintenance of IP, IP licensing; and negotiation and approval of IP and business agreements with industry. At Technion Technology Transfer (T3)[18], between 2016 and 2017 they achieved 90 commercialisation agreements, raised circa US$100 million from affiliated companies and achieved revenue of US$31 million. Similar successes were achieved at other universities such as Yissum[19] the technology transfer company of the Hebrew University.

At Yissum, a staff of 27 facilitate long-term, industry-university collaborations through licensing, and sponsored and collaborative research. They offer support for start-up creation, leverage government research funds and outreach operations into industry. Students are offered mentorship and support for entrepreneurial projects via a funded programme: HUstart.[20] Additional accelerator support and business incubation support is available through the HUGROW[21] and Labs/02[22] projects respectively. The approach is similar across all the universities in Israel with the focus being relevant to the areas of research important to each university. The perception of the mission experts was that technology transfer staff operate at a higher level than similar staff in the UK, and work within a well-resourced organisation with very clear objectives and a strong commercial focus.

Academic staff are encouraged to seek all opportunities to commercialise their research. They are permitted to work one-day-per-week on industrial or applied research projects from which they may achieve personal reward. There are no compulsory requirements to commercialise research. However, the incentives are quite significant. At Technion the initial equity split of any commercial gain is 50:50 between the university and the inventor, compared to even the most generous agreements at UK universities, this is significantly greater.

Universities do not undertake their research in isolation. The state-funded programmes of support enable industry and academia to collaborate on areas of research. In universities there are many examples of long-term programmes of collaboration with large multinational organisations investing in facilities and research.

2.6.1 Incubator Incentive Programme

The IIA operates an Incubator Incentive Programme for entrepreneurs interested in establishing a start-up company based on an innovative technological concept. A technological incubator is a centre for entrepreneurship intended to invest in new start-up companies and provide administrative, technological and business support.

The incubator offers a supportive framework for the establishment of a company and the development of a concept into a commercial product. There are currently 18 technological incubators and one designated biotechnological incubator, which are privately owned by groups, such as venture capital funds, multinational corporations, as well as private investors and others. The incubators are selected through a competitive process for a license period of eight years and are spread across Israel.

The purpose of the incentive programme is to support private entrepreneurs with innovative technological concepts at the initial stage of R&D in establishing new start-up companies and help them reach a significant fundable milestone.

Support includes:

- A conditional grant provided as part of the incentive programme for 85% of the approved budget, with a budget limit of NIS3.5 million (approx US$955K, Jan 2019) for a period of up to two years (depending on project type and geographical location of the incubator). Beneficiaries can get an additional grant for a third year in accordance with the programme regulations.
- The conditional grant provided as part of the biotechnological incubator is 85% of the approved budget, with a budget limit of NIS8.1 million (approx US$2.2 million, Jan 2019) for a period of up to three years.

1. Supplementary investment financing of 15% of the approved budget by the incubator, which completes 100% of the total budget. No financial investment is required by the entrepreneur.
2. Comprehensive assistance is available from the incubator, including physical space and infrastructure, administrative services, technological and business guidance, legal advice and access to partners, additional investors and potential customers.

The entrepreneurs are not obliged to establish a company before the project is approved by the IIA.

The incubator is a partner with vast experience and expertise in leading start-ups and commercialising products. It facilitates follow-on investments in companies that have graduated from the incubator and assists them in market penetration.

2.6.2 Accelerators

Accelerators established by universities and private companies are also employed to assist the technology transfer process. Mentorship, alumni support and help to access funding and resources are all provided along with the provision of work/office space and targeted funding provided by the universities and private investors.

[18] www.t3.trdf.co.il
[19] www.yissum.co.il
[20] www.hustart.com
[21] www.hugrow.com
[22] www.labs02.com

3. Conclusions

The Advanced Materials Expert Mission to Israel was successful in reinforcing existing relationships, fostering new partnerships and future bilateral collaborations, and identifying the practical next steps to building fruitful and profitable partnerships.

There are significant opportunities for collaboration between the UK and Israel in advanced materials based on a range of activities including horizon-scanning, joint road-mapping, global landscape studies, collaborative R&D, pilot-scale and full-scale manufacturing. The Expert Mission participants came away convinced that Israel has a particularly strong national strategy that encourages innovation and entrepreneurial activity at all levels of society – although it was felt that success to date has primarily been in the high-tech (with nanotechnology specifically highlighted) and ICT sectors.

Culturally Israel has a strong identity reinforced by compulsory national service and a Start-Up Nation mentality that celebrates innovation. Failure is not seen as a negative outcome but is used to reinforce a can-do attitude and encourage everyone to achieve their potential.

Innovation in the UK has recently been stimulated by the creation of UK Research and Innovation (UKRI). Operating across the whole of the UK with a combined budget of more than £6 billion, UKRI brings together the seven Research Councils, Innovate UK and a new organisation, Research England[23]. Similarly, the £235 million budget of the Henry Royce Institute will grow the UK's world-leading R&D and innovation base in advanced materials science. It operates as a hub-and-spoke model, with the hub at the University of Manchester, and spokes at the founding partners potentially comprising of the universities of Sheffield[24] Leeds[25], Liverpool[26], Cambridge[27], Oxford[28] and Imperial College London[29], as well as the UK Atomic Energy Authority (UKAEA)[30] and National Nuclear Laboratory (NNL)[31]. In the future, the Henry Royce Institute would like to grow their partners and collaborators to include as many of the UK's leading materials scientists as possible.

[23] https://re.ukri.org
[24] www.sheffield.ac.uk
[25] www.leeds.ac.uk
[26] www.liverpool.ac.uk
[27] www.cambridge.ac.uk
[28] www.ox.ac.uk
[29] www.imperial.ac.uk
[30] www.gov.uk/government/organisations/uk-atomic-energy-authority
[31] www.nnl.co.uk

Annex 1
List of UK Participants

The Catapult Centre	https://catapult.org.uk
DZP Technologies	www.dzptechnologies.com
Innovate UK	http:/ukri.org
Knowledge Transfer Network	https://ktn-uk.co.uk
Kymira	www.kymirasport.com
Metalysis	www.metalysis.com
Paragraf	http://paragraf.com
Promethean Particles	www.prometheanparticles.co.uk
Smart Separations	https://smartseparations.com
UK Science and Innovation Network (SIN) Israel	www.gov.uk/world/organisations/uk-science-innovation-network-in-israel
University of Cambridge	www.cam.ac.uk
University of Oxford	www.ox.ac.uk
Versarien plc	www.versarien.com

Israel Participants

Ben-Gurion University of the Negev, Zuckerberg Institute of Water Research	http://www.atp-israel.com/bgu/ziwr.html
Copprint	http://copprint.com
FeelIT	www.feelit.tech
Graphene-Info	www.graphene-info.com
Israel Aerospace Industries Ltd	http://www.iai.co.il
Israel-Europe R&I Directorate (ISERD)	
Israel Innovation Authority (IIA)	
Israeli Ministry of Defence (IMOD)	
Israel National Nanotechnology Initiative (INNI)	
MASSIVit 3D	massivit3d.com
MemTech Ltd	http://memtech-water.com
Nano Dimension Ltd	www.nano-di.com
SP Nano Ltd	http://www.spnano.com
Seevix Material Sciences	http://seevix.com
Technion University: Israel Institute of Technology	
Tortech Nano Fibers Ltd	

Annex 2

Funding Programmes Offered by the Israel Innovation Authority

The programmes most relevant to advanced materials research and development are MAGNET, MAGNETON, KAMIN and NOFAR.

MAGNET Consortiums	
The MAGNET incentive programme (Generic Pre-Competitive Technological R&D) focuses on consortiums of industrial companies and research institutions that collaborate to develop innovative technologies	
Goal	To assist in the development of generic technologies in important fields in the global market, in which Israeli industry has a competitive advantage. Since the incentive programme specialises in the development of infrastructural technology, it allows distribution of knowledge and cooperation between companies operating in the same field, which may be difficult to achieve otherwise.
Beneficiaries	• Manufacturing companies developing competitive products and simultaneously seeking to develop innovative technologies, which can be used as a basis to develop a new and advanced generation of products. • Academic research groups engaged in scientific or technological research, seeking to promote applied research as part of a consortium, as well as to collaborate with the industry and study the market needs.
Funding available	• The amount of the grant provided through the consortium is up to 66% of the approved budget for an industrial company and 100% of the approved budget for a research institution (80% as a grant and 20% from the industrial companies in the consortium). • The operating period is three-to-five-years, in order to facilitate a long-term R&D process.

MAGNETON Incentive Programme	
The MAGNETON incentive programme encourages the transfer of technological knowledge accumulated in academia for the use of industry, by creating collaborations between Israeli companies and academic research groups. These collaborations expose industrial companies to the research achievements relevant to their activities and assist research groups in transforming academic developments into commercial applications.	
Goal	To transfer technology from research institutions to industrial corporations for the development of breakthrough products.
Beneficiaries	• Industrial companies seeking to incorporate new technologies developed in academia and striving to develop a new product or to improve an existing product based on recent studies, relevant to their field of activity. • Academic research groups from Israeli research institutes and think tanks approved by the Technological Infrastructure Division, seeking to carry out innovative and original applied research in collaboration with a leading company interested in the relevant technology. The research should be focused on technological feasibility for the industry, and the applying research institute should be the sole owner of knowledge in the project.
Funding available	• An applied research grant of up to 66% of the approved budget, up to a total of NIS3.4 million (approx US$925K) for a period of 24 months. The academic research group receives the full budget: 66% of which will be provided by the Technological Infrastructure Division, and the rest by the partner company. • The grant recipients are exempt from paying royalties for repayment of grant funds transferred to them.

NOFAR Incentive Programme	
The NOFAR incentive programme provides support for applied research in academia, thus potentially increasing its economic contribution to the economy. This incentive programme focuses on technologically-feasible ideas, which are not mature enough for the support of the MAGNETON incentive programme, but require financing in the initial applied research stage at universities in order to match them with the appropriate industrial sector. The NOFAR incentive programme is limited to the fields of biotechnology and nanotechnology, for a period of one year.	
Goal	To bridge the gap between academic knowledge and industry needs. All the research activities carried out as part of this incentive programme are in academic institutions, accompanied by the support of an industrial company that sees business potential in the achievements of the project. The main goal is to reach significant milestones by the end of the project, which will enable the industrial company to sign a technology commercialisation agreement with the research institute. The research activities in the incentive programme will receive professional support by an industrial company or a relevant business entity (such as a venture capital fund).
Beneficiaries	• Academic research groups, operating as part of a higher education or research institution, seeking to carry out applied research, which is not mature enough to be supported by the industry or by the MAGNETON incentive programme. • The research should include a new and original idea that requires proof of concept, with preliminary basic research and results that are applicable to industry.
Funding available	• The research institution supported by the NOFAR incentive programme is entitled to a grant of up to 90% of the approved budget with a maximum scope of NIS550K (approx US$150K) for a period of 12 months, with an option to extend the support up to 15 months. • The supporting company serves as partner in professional guidance and in setting of research goals, as well as participates in the funding of 10% of the project cost. • At the end of the research, the supporting company receives the first right to negotiate a commercialisation agreement with the research institution. • NOFAR research conducted in collaboration with two different institutions is eligible for funding of up to NIS660K (approx US$180K). • The grant recipients are exempt from repayment of royalties. • The incentive programme offers two fixed annual deadlines: November 30 and May 31

The Advanced Technologies Users' Association	
This incentive programme allows joint activity of a group of industrial corporations as part of the Advanced Technologies Users' Association. The main idea of the incentive programme is based on the notion that "the whole is greater than the sum of its parts." In other words, though cooperation the companies learn from the experience of each other, thus increasing their knowledge and skills.	
Goal	Distribution, implementation, and demonstration of technologies or sharing resources in a way that contributes to R&D in the fields of practice of the companies.
Beneficiaries	Companies engaged in R&D and interested in collaboration in the distribution and implementation of new technologies.
Funding available	The Association, as a legal entity, receives a grant of up to 66% of the approved expenses. The members of the Association complete this sum to 100% of the Association's expenses. Companies do not receive any grants as part of this incentive programme.

Industrial Research Institutes	
This incentive programme assists and supports research institutions conducting applied research promoting industry in Israel. The support is provided via two incentive programmes: the financial support programme for R&D processes in cooperation with an industrial company; and the assistance programme for the purchase of laboratory and scientific equipment. Interested parties may apply to both programmes simultaneously.	
Goal	To provide assistance and support to research institutions that conduct applied research whose goal is the further development of Israeli industry.
Beneficiaries	• Research institutes operating as independent legal entities engaged in applied R&D and providing counselling and testing services for industrial corporations. The complete list of conditions and criteria is detailed on the Authority's website. • Commercial companies interested in collaboration with research institutes.
Funding available	• Grant funds are to be used for the financing of the R&D incentive programme and/or the equipment purchase incentive programme. The benefit will be provided for a period of one year, with the possibility to apply for support for an additional year. • The research institutes committee can approve a grant request for a third year for the incentive programme relevant to the industry sectors declared as prioritised.

TZATAM Incentive Programme	
The TZATAM incentive programme (Life Sciences R&D Supporting Equipment) offers financial support to organisations that focus on providing services to other companies for the purpose of research and development processes in the life sciences field.	
Goal	To expand the infrastructure used for industrial R&D in life sciences and to provide Israeli entities with access to R&D services that were unavailable in the country until recently. The grant is provided for the purchase of advanced laboratory equipment, and its main purpose is to strengthen and expand R&D capacities in the field of life sciences, necessary for controlled feasibility assessment of scientific and technological findings, as well as receipt of regulatory approvals for clinical trials.
Beneficiaries	• Business entities whose activity is based on providing services to R&D processes in the life sciences field, particularly in the areas of stem cell research and biomedical research. • Entities interested in financial support to expand their existing services by purchasing laboratory equipment for research in the field of life sciences.
Funding available	• A grant of 50% of the approved budget for the purchase of laboratory equipment for the purposes of service, R&D. • The grant recipients are exempt from paying royalties to the authority. • Incentive programme conditions: o The application should include details of the research equipment or laboratory equipment, the cost of which is at least US$150K. o The grant recipients must deliver an annual report to the incentive programme administration, regarding all the services provided using the equipment purchased with the grant money. • Participation in financing of personnel training for the use of new equipment only, as the training period will not exceed three months and will be limited for a period until the beginning of the service provision. • The grant recipients will undertake to provide impartial service to all organisations engaged in R&D in life sciences for a period of at least three years, which will start five months from receiving approval. • The tariffs for the provision of the service will be governed by a committee of the incentive programme administration.

KAMIN	
The KAMIN incentive programme serves as a bridge between basic and applied research and is focused on the stage of transformation and realisation of basic research achievements into technologies with commercial application.	
Goal	To encourage applied research in academia that can attract the investment interests of business entities willing to cooperate with the research institution towards a commercialisation agreement.
Beneficiaries	Research groups from universities, colleges, research institutes and medical centres that seek to conduct applied research, building upon the basic research. The research must be innovative and original in terms of industrial application; its results should be applicable to industries in Israel and potentially have high added-value for the entire economy
Funding available	• Conditional grant of 85-90% of the approved budget, up to a maximum amount of NIS400K (approx US$109K). • The support is provided for a period of one or two years, with the possibility to extend this period in exceptional cases with a reduced grant of 66% of the approved budget. • The grant recipients are exempt from repayment of royalties.

MEIMAD	
Operating since 2012, MEIMAD is a joint venture of the IIA, Ministry of Finance and the Administration for the Development of Weapons and Technological Infrastructure of the Ministry of Defence. This incentive programme supports the development of creative solutions for military and commercial markets by leveraging military, defence and commercial R&D for dual-use technologies.	
Goal	To promote military/defence and commercial R&D of dual-use technologies, which on the one hand constitute a contribution to national security, and on the other hand possess financial potential.
Beneficiaries	• Israeli small and medium-sized companies (up to US$50 million in sales per year). • University research institutes and research centre.
Funding available	A grant of 50-90% in accordance with the type and nature of the activity. **Leveraging of capabilities:** The R&D activities in this incentive programme provide an opportunity to transfer military capabilities to the civilian market and vice versa.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