

Nano-Carbon Enhanced Materials (NCEM) Consortium

The 1st Nano-Carbon Enhanced Materials (NCEM-1) consortium has been launched in April 2012 by the **Centre for Business Innovation Ltd** (www.cfbi.com) in order to provide the consortium members a unique insight into carbon nanotechnologies and an opportunity to address commercialisation challenges. The consortium leader **Dr Bojan Boskovic**, from **Cambridge Nanomaterials Technology Ltd** (www.cnt-ltd.co.uk), is an expert in nano-carbon commercialisation. In the first five meetings of the NCEM-1 consortium in the first year and in the following five meetings of the NCEM-2 consortium in the second year more than 40 organisations from 12 countries participated providing delegates and speakers (see some of the participant organisation logos below). The NCEM consortium is now entering the 3rd year. The **NCEM-3** consortium is starting in June 2014 with a meeting in Grenoble co-organised by Schneider-Electric and it is **open for new members**.



The NCEM consortium is providing an opportunity to engage with leading companies in the supply chain and also with leading world class experts in a commercialisation pathfinder programme for a small fraction of time and total costs of alternatives such as consultancy, meetings, workshops and conferences. The use of nano-carbon materials, such as carbon nanotubes and graphene is a rapidly evolving field and this is an opportunity to influence where and how fast it goes, and to facilitate the commercialisation. The mission of the consortium is to facilitate the commercial uptake of technologies based on nano-carbon materials such as graphene and carbon nanotubes, and to bring together potential users from defense, energy, electronics, structural materials and metal industries, with a shared interest in understanding the challenges and opportunities of nano-carbon technologies.

The NCEM-1 and NCEM-2 consortium members: University of Cambridge (UK); Nokia Research Centre (UK); ST Microelectronics (Italy); International Copper Association (USA); Nexans (France); Bosch (Germany); Codelco (Chile), National Grid (UK), Trinity College Dublin (Ireland), Arup (UK) and Statnett (Norway), Schneider Electric (France) and Airbus Group (UK).

The last NCEM-2 meeting (**NCEM-2.5**) was in Cambridge, MA, USA on 14th May 2014 with an open-day meeting on 15th May 2014. **Dr John Hart** from the **Department of Mechanical Engineering** at the **MIT** presented nano-carbon related research activities of his team and gave the consortium member a tour of his laboratory at the MIT. **Dr Brian Wardle** from the **Department of Aeronautics and Astronautics** at the **MIT** gave presentation about his nano-carbon related composite aerospace structures research. **Peter Antoinette**, **CEO of Nanocomp Technologies** presented their carbon nanotube fiber products and talk about the carbon nanotube product company journey through the valley of death. **David Arthur**, **CEO of the SWeNT** in the US, one of the leading Single Wall Nanotube (SWNT) producers gave an update on their production and application development activities. **Dr Elsa Olivetti** from **Department of Materials Science and Engineering** at the **MIT** discussed issues in her presentation related to potential for displacement of traditional materials, especially metals by major novel nano-carbon material technologies. **Dr Elena Polyakova**, **CEO of the Graphene Laboratories, Inc (Graphene Supermarket)**, spoke about the graphene market and other 2D materials. **Dr Erick Thostenson** from **University of Delaware** gave presentation about nano-carbon composites including structural health monitoring. **Dr Alfred A. Zinn** from **Lockheed Martin Space Systems Company** gave presentation about nanoenabled electronics. **Dr David R. Forrest** from the **U.S. Department of Energy** gave presentation regarding the U.S. Government initiative on development of the network of Manufacturing Innovation Institutes.

The NCEM-1 consortium meetings were in Cambridge (England), Edinburgh (Scotland), Brussels (Belgium), Stuttgart (Germany) and Dublin (Ireland). The NCEM-2 consortium meetings were in Cambridge (England), San Sebastian (Spain), London (England), Dublin (Ireland) and the final meeting of the NCEM-2 was in Boston (USA).

Responding to the NCEM members' demand, the consortium meetings were themed and organised around challenges and opportunities for nano-carbon:

- State-of-the-art development of carbon nanotube and graphene applications (All meetings)
- State-of-the-art development of carbon nanotube fibres/cables and their applications (Cambridge, Boston)
- State of the art use of graphene in mobile phone applications (Cambridge, Edinburgh, Stuttgart)
- State of the art and opportunities for carbon nanotube copper composites (Cambridge, Edinburgh, Brussels, Dublin, Boston)
- State-of-the art review in nano-carbon toxicology, safe handling practices and risk assessment (Edinburgh)
- State of the art graphene electronic and electrical applications (Edinburgh, Stuttgart, Dublin, London)
- State of the art in carbon nanotube and graphene structural composite applications (San Sebastian, Boston)

- State of the art in carbon nanotube and graphene electrochemical and energy storage applications (Stuttgart, San Sebastian)
- Carbon nanotube and graphene large-scale production challenges (Brussels, Dublin, San Sebastian, Boston)
- Nanomaterials and EU regulations (Brussels)
- Collaborative R&D funding in Europe (FP7 & Horizon 2020) (Brussels, San Sebastian, London, Dublin)

The 1st NCEM-1 (**NCEM-1.1**) Cambridge meeting was held on 18th & 19th April 2012 in Downing College and delegates were addressed by leading academics from the University of Cambridge and experts in the field of nano-carbon materials: Prof. Bill Milne from the Department of Engineering who gave a presentation about nano-carbon electronics; and Prof. Alan Windle and Dr. Krzysztof Koziol from the Department of Materials Science and Metallurgy who presented scientific advances and commercialisation challenges related to carbon nanotube fibre technology. The consortium members from Nokia Research Centre (UK) and International Copper Association also gave presentations about their vision and challenges related to the commercialisation of nano-carbon technology in mobile electronics and copper metal composite applications.



The 1st NCEM-1 meeting at Downing College in Cambridge

Malcolm Burwell from International Copper Association commented after the 1st NCEM consortium meeting: ***“We all felt that the value obtained from the single meeting that we just had justified the yearly fees on its own.”***

The 2nd NCEM-1 (**NCEM-1.2**) meeting took place on 18th and 19th July 2012 in Edinburgh’s Dalmahoy Marriott Hotel and Country Club, the Scottish Baronial Manor set in 1000 acres of parkland and one of Scotland’s premier golfing venues. The morning session started with the Masterclass in NanoSafety delivered by Dr Steve Hankin and Dr Craig Poland from the Institute of Occupational Medicine from Edinburgh. This was followed Dr Kyle Kissell, Director of Technology Development from NanoRidge, USA who presented recent developments in incorporating highly conductive carbon nanotubes into copper metal that resulted in a composite material with superior properties. His presentation was followed by a presentation from Dr Francesco Bonaccorso from the University of Cambridge on graphene applications in electronics and an update about European FP7 NMP 2013 call for collaborative R&D proposals by Dr Bojan Boskovic.



Venue of the 2nd NCEM-1 was Dalmahoy Marriott Hotel in Edinburgh

Dr Kyle Kissell, Technology Director from NanoRidge in Houston, Texas commented after the 2nd NCEM meeting: ***“I believe that consortia like this are a critical step towards bridging the gap between extraordinary science and product commercialization. We feel privileged to be invited to speak to a group that is interested in DOING something as opposed to just TALKING about something. The connections we created during the two days of interactions will be crucial for the success of our products and our company.”***

Dr Anna Gergely from Steptoe & Johnson LLP co-hosted the 3rd NCEM-1 (**NCEM-1.3**) meeting on 6th and 7th November 2012 in Brussels. She also presented an insight into nanomaterials- related

regulations in the EU at the meeting. Guest speakers also included Dr David Arthur CEO of the SWeNT in the US, one of the leading Single Wall Nanotube (SWNT) producers and Dr Peter Krueger, Head of Working Group Nanotechnology, Bayer MaterialScience, Germany. Peter is also leading Inno.CNT, a €90M German Government supported programme about carbon nanotube commercialisation. Christos Tokamanis, who is Head of Nano Sciences and Technologies at the European Commission (EC) in Brussels, gave a presentation about FP7 NMP Theme and an insight into nanotechnologies and nanomaterials within a new Horizon2020.

Following successful meeting in Brussels, the consortium submitted EC FP7 UltraWire project proposals in December 2012 that included 4 consortium members and 2 of organisations that provided speakers at the consortium meetings. The UltraWire project has been granted €3.3M by the EC and it started on 1st October 2013 (www.ultrawire.eu).



Christos Tokamanis, from the European Commission presenting at the 3rd NCEM-1 meeting in Brussels

Ivica Kolaric and his team from Fraunhofer IPA in Stuttgart were co-hosting the 4th NCEM-1 (**NCEM-1.4**) meeting on 27th and 28th February 2013 and also providing us with an insight into carbon nanomaterials related research activities at Fraunhofer IPA including carbon nanotube metal composites and graphene supercapacitors. The NCEM-1.4 meeting delegates were given a tour of the Fraunhofer IPA laboratories. Dr Andre Zimmermann from Bosch in Stuttgart introduced Bosch Group and give presentation about potential and challenges of polymers in electronics. Jesus de la Fuente, CEO of Graphenea from San Sebastian in Spain presented graphene manufacturing activities at Graphenea. Stefano Borini from Nokia Reserch Centre in Cambridge gave a presentation of graphene technology for future portable devices and give an update of Nokia's

activities regarding graphene including Graphene Flagship programme. Dr Bojan Boskovic, NCEM Programme Director, gave an update of consortium activities including success with the EC FP7 project proposal entering the EC negotiation stage. Statnett from Norway was welcomed as new member of the consortium.

Dr Chris Keely and his team and the CRANN, Trinity College Dublin were co-hosting the 5th NCEM-1 (**NCEM-1.5**) meeting on 15th and 16th April 2013 in Dublin and providing delegates with an insight into nano-carbon enhanced materials related research activities at the CRANN. Dr Georg Duesberg from CRANN talked about latest research in carbon based nano-structures for electronic and energy devices. Dr Ryan Enright from Alcatel Lucent Bell labs Ireland gave a talk about role of nanoscience in advanced thermal management from ICT/Telecom perspective. Dr Andy Goodwin gave an overview of carbon nanomaterial production and research activities at Thomas Swan & Co. Mark Bowers from Arup talked about carbon nanomaterial applications in construction industry and role of Arup. Malcolm Burwell from Copper Industry Association gave an update on development of ultraconductive copper-carbon nanotube composites.

The 2nd NCEM consortium (**NCEM-2**) started with the first meeting (**NCEM-2.1**) in Nokia Research Centre in Cambridge on 10th July 2013 and an opening dinner at the Trinity Hall College on 9th July. The NCEM-2.1 Cambridge meeting co-organisers from Nokia gave presentation about Nokia Research Centre and nano-carbon related research activities including Graphene Flagship Programme. Dr Karl Coleman, CTO and Claudio Marinelli, Business Development Director from Durham Graphene Science (DGS) presented graphene manufacturing capacities, and discussed plans and opportunities for collaboration with DGS. Dr Krystof Koziol from Department of Materials Science and Metallurgy at the University of Cambridge gave an update on his research activities including information about the FP7 UltraWire project. Dr Haider Butt from Department of Engineering at the University of Cambridge gave a presentation about optical holograms based on carbon nanotubes. Adam Geen from the National Grid gave an overview about National Grid and opportunities for use of nano-carbon materials in electrical energy transmission applications.

Jesús de la Fuente and his team from Graphenea were co-hosting the 2nd NCEM-2 (**NCEM-2.2**) meeting on 7th and 8th October 2013 in San Sebastian and also providing an insight into graphene manufacturing and research activities at Graphenea. Dr. Amaia Zurutuza, Scientific Director at Graphenea, gave presentation about graphene applications and research activities at Graphenea. Jose Luis León, General Manager IDEC.aero - Advanced Composites Manufacturer for Airbus and Airbus Military (Spain) gave a presentation about carbon nanomaterials in aerospace composites. Francis Massin, CEO of Nanocyl (Belgium) gave a presentation about carbon nanotube manufacturing, product development and research at Nanocyl, one of the leading carbon nanotube manufacturers. Dr. J. Alberto Blázquez gave a presentation about experience of CEGASA and IK4-CIDETEC (Spain) about choosing the right nano-carbon materials for battery and fuel cell applications. Dr. Teresa Álvarez Centeno from Instituto Nacional del Carbón – CSIC, Oviedo, (Spain) gave a presentation about carbon nanomaterials in supercapacitors including reflection to the work done in the FP7 ElectroGraph project regarding development of graphene supercapacitor electrodes. Dr Virginia Ruiz from the Nanomaterials Unit, IK4-CIDETEC (Spain) gave a presentation about diversified activities on carbon nanomaterials research in their group. Schneider Electric from France was welcomed as new member of the consortium.



Consortium dinner at the 2nd NCEM-2 meeting in San Sebastian

The 3rd NCEM-2 meeting (**NCEM-2.3**) has been co-hosted by Arup on 26th November 2013 with an opening dinner on 25th November. At the meeting speakers from Arup provided insight into: 1) products they developed and attitude towards industrial collaboration, 2) the research processes they follow and strategic areas for research and 3) opportunities for carbon nanomaterials in construction industry. Prof. Nicole Grobert from the Oxford University gave an overview of carbon nanotube and graphene synthesis and application related activities of her team. Dr Richard van Rijn, CTO from Applied Nanolayers from Netherland gave a talk about opportunities and challenges for graphene wafer scale production. Stuart Morris CEO of the GasPlas presented interesting technology for improving gas decomposition efficiency of the CVD

nano-carbon production process. Dr Chris Keely, Business Development Director at CRANN, Trinity College Dublin talked about launch of their new AMBER (Advanced Materials and Bio Engineering Research) centre with €58M investment over 6 years that is looking for partnership with industry and academia. Dr Zoe Webster, Head of Technology at the Technology Strategy Board gave an overview of the UK government investment in nanotechnologies. The meeting also provided an introduction to upcoming H2020 NMP call and an opportunity for partnering discussions related to the call facilitated by Dr Bojan Boskovic based on the latest H2020 NMP call draft document.

The 4th NCEM-2 meeting (**NCEM-2.4**) meeting in Dublin on 27th February 2014 with an opening dinner on 26th February 2014 has been co-organised by Dr Chris Keely and Dr Colm Faulkner and their team from Trinity College Dublin CRANN/AMBER centre. Dr Georg Duesberg from CRANN talked about latest research in carbon based nano-structures for electronic and energy devices. He was followed by two other CRANN researches Dr Shane Bergin and Dr Beatriz Mendoza-Sánchez. Dr Ryan Enright from Alcatel Lucent Bell Labs Ireland gave a talk about role of nanoscience in advanced thermal management from ICT/Telecom perspective. Dr Nathalie Caillault from Schneider Electric gave an overview of perspective on application of carbon-nanomaterials. Prof. Pagona Papakonstantinou from Nanotechnology and Integrated Bioengineering Centre at University of Ulster, Ireland talked about energy storage and production with graphene enabled materials. The meeting also provided an opportunity for partnering discussions related to the H2020 NMP calls facilitated by Dr Bojan Boskovic.

For further details and information how to join the consortium please contact Dr Bojan Boskovic who is a leader of the consortium: Bojan.Boskovic@cnt-ltd.co.uk or Bojan.Boskovic@cfbi.com.