institutions of DST, DBT, MoES, IITs, AICTE, UGC, Central Water Commission and BrahMos, participated and highlighted the outstanding achievements of science and technology and R&D institutes of India. At the International Science Film Festival, short films were screened, relevant to our country's scientific needs and aspirations, under various themes: sciences for the masses, scientific approach to problem solving; health awareness with special reference to vector borne diseases; food safety and climate change; indigenous science; ideas and innovations and my perception of science.

In the valedictory function, Harsh Vardhan emphasized on the grand success of 2nd IISF-2016 which set a unique example of an inimitable festival in bridging the gap between Indian scientific innovations and practices. He also assured the entire youth gathered during the function that the upcoming IISF meet will provide newer avenues for school students especially from rural areas, young researchers and academicians to rise to greater heights. This platform would pave the way in developing new strategies and horizons in science and technology. During this function, young students were awarded for their outstanding projects under the DST INSPIRE programme. Various presentations (both oral and posters) and mega science, technology and industry expo were also awarded. With the motto of 'science for the masses', this science festival once again created a platform which is an integral part of India's march to creating an innovative society that can play a role in 'Indian Innovation Economy'.

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MEETING REPORT

Green chemistry and engineering for sustainable development*

Many chemicals and compounds currently in use are creating an adverse impact on environment and human health. Green chemistry is therefore aiming to develop products which are safe and employ processes that cause minimum damage to the environment.

The GCE 2016 symposium was inaugurated by Suojiang Zhang (Director IPE). It provided a platform for discussions on the latest research and innovation in science and technology of green chemistry for sustainable development. The topics covered included a wide spectrum of renewable energy sources, catalysis, nanotechnology, computational chemistry, energy storage and supercapacitors, green solvents and green carbon science and technology. In the two and half-a-day symposium, there were 11 plenary lectures delivered by scientists from China, India and Korea. In addition to plenary and invited lectures, 37 poster presentations were held. Participants were from Mongolia, Myanmar, Thailand, Vietnam and Pakistan in addition to those mentioned above.

Two main highlights of the symposium were Green Catalysis and Green Solvents. As catalysts are used in almost 25% of all chemical reactions, to avoid their adverse impact on the environment, green catalysis provides solutions in green chemistry by reducing the amount of waste generation. The catalyst is either recyclable or degradable. Metal Organic Frameworks (MOFs) act as precursor to green catalysis for many reactions. MOFs are known CO_2 capture materials and are used for carbon conversion and utilization, said J. Li (Beijing University of Technology, China).

Green solvents are replacing conventional solvents to minimize their chemical persistence in the environment. At present almost 75% of the chemical reactions need solvents and approximately 20 million tonnes of organic solvents are discharged into the environment every year. Most vital green solvents are CO_2 in supercritical phase, water as well as ionic liquids (ILs). The ILs made of organic salts, constituted by ion pairs having low melting point, are most promising. They can dissolve cellulose for biofuels, used in hydrocarbons separation, for CO_2 capture and many other potential applications. Many presentations in the symposium were on advanced research in ILs as green solvents and their applications in CO_2 conversion. Performance improvement research on hydrotalcites and ILs were presented by C. Li and team (IPE).

On carbon capture storage and utilization (CCSU), there were a few papers, though none talked of storage. Malti Goel (Climate Change Research Institute and Former Adviser, Government of India) described recent advances in carbon capture and utilization taking place for mitigation of climate change. Green technology perspectives from energy intensive industry were presented. China being the highest coal user in the world and the chief emitter of CO_2 has carried out several assessments of improving the efficiency of CO_2 utilization processes. In the symposium Z. Liu (Institute of Chemistry, CAS, China) discussed research on microporous fluorinated organic polymers for CO_2 capture and conversion. Phenolic azo-polymers exhibit a high CO_2/N_2 separation selectivity. B. Han (also from Institute of Chemistry), while discussing properties and uses of

*A report on the CAS-TWAS Symposium on Green Chemistry and Engineering for Sustainable Development (GCE 2016), held in Beijing during 28–31 August 2016. It was hosted by the Chinese Academy of Science (CAS). The World Academy of Science for the Advancement of Science in Developing Countries (TWAS) and Organized by the Institute of Process Engineering (IPE), CAS.

green solvents explained supercritical fluids that can act as green solvent for CO_2. He described the hydrogenation process for its conversion into formic acid.

Advancements are being made increasingly for energy storage applications in graphene-based metal compounds. Advanced studies being made in Yeungnam University, Korea on metal oxide-graphene based nanocomposites for application in lithium–ion batteries and super capacitors were presented by Jae Jin Shim. He said flexible supercapacitor electrode materials made of polymer graphene oxide composites are finding applications in smart wearable devices. S. Sahoo from his team described research in super-capacitor applications. Z. Liu (Peking University) gave a perspective of the many uses of high quality graphene powders and described its unique properties as super graphene glass (SGG) for 'smart windows', antifogging glass in automobiles and as biosensors, among others.

Graphene which comprises a single layer of carbon atoms arranged in a honeycomb lattice, is the thinnest and strongest material known. China is having the highest number of patents on this wonder material, also seen as future replacement of silicon in electronics. A Graphene Industrial Park exists in China with a vision to develop rapidly growing uses in super-capacitor and energy storage applications.

There were interesting presentations on dye-sensitized solar cells, nanotechnology, conversion of biomass into biofuels and efforts made by Biomass Industries Confederation (Malaysia) to utilize them and to promote sustainable development of biomass industry. S. Bhattacharya (Indian Association for the Cultivation of Science, Kolkata) presented multifarious facets of research in creation of molecular gel nanostructures for applications. The symposium also covered biomedical and bimolecular interactions' frontline research in green chemistry. Computational booster of protein structures in living beings for enhanced drug delivery was presented by H. Jiang (Shanghai Institute of Materia Medica, China). NMR spectroscopy of molecular interactions in bio-systems viz. blood plasma and cells for disease detection and remedial actions was described by M. Liu (Wuhan Institute of Physics and Mathematics).

Another important topic covered in the symposium was toxicity caused by nanomaterials and nanoparticles in the atmosphere. Smaller particles cause highest damage to body organs, and need to be investigated said Y. Zhao (National Center for Nanoscience and Technology). On the other hand various toxic and non-toxic pollutants such as CO_2 and other greenhouse gases cause threat of global warming and climate change. In India coal is a dominant energy resource, meeting almost 70% of our energy needs. In China extensive research is being pursued on topics such as CO_2 conversion, green solvents and graphene development. Only glimpses are presented here. Looking at India's strengths in these areas and our Science and Technology co-operations with China, I suggest that the time is ripe to develop science diplomacy with China on carbon science and technology for public good. The experts could delineate specific areas to find out solutions not only in climate change space, but also to channelize scientific research towards green chemistry.

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MEETING REPORT

Monitoring the spread and management of *Tuta absoluta**

The leafminer is a native of South America and it was first described from the specimens collected in Peru in 1917. It belongs to the family Gelechiidae, that includes other important agricultural pests such as the potato tuber moth (*Phthorimaea operculella*), pink bollworm (*Pectinosphora gossypiella*), tomato pinworm (*Keiferia lycopersicella*) and Guatemalan potato moth (*Tecia solanivora*).

In 2006, *T. absoluta* was accidentally introduced to Spain from Chile and by 2009 it had spread to most of the European countries and crossed the Mediterranean Sea, reaching North African countries. By 2011, it had invaded countries in the Middle East and by 2014, it had crossed the Arabian Sea and established in the Pune area of India. In May 2016, it was recorded in some parts of Bangladesh and Nepal, along with Uzbekistan, Afghanistan and Tajikistan. In Africa, it has already invaded eastern and southern Africa, and some countries in western Africa.

This pest is capable of causing total crop loss unless control measures are instituted. Its preferred host is tomato, but it can also attack brinjal, potato, pepper and tobacco, and can develop on solanaceous weeds successfully.

The symposium began with a presentation by Rangaswamy Muniappan (Feed the Future Innovation Lab for Integrated Pest Management (IPM IL)), a program funded by USAID and managed by Virginia Tech. He gave an overview of the workshops conducted by the IPM IL program in various countries in Africa and Asia and explained that their objective was to create awareness of *T. absoluta* before its invasion, and to discuss ways to manage this pest if it shows up. The IPM IL has conducted over a dozen such workshops, reaching scientists, farmers and policy makers in more than 40 countries. A member of the BioControl Research Laboratories in Bengaluru attended one of these workshops in Addis Ababa, Ethiopia in December 2013, and based on what she learned, the company prepared *T. absoluta* pheromone lures and traps. These traps were used for monitoring the arrival of *T. absoluta* in India, and once the pest did arrive, the

*A report of the symposium on the 'Global Spread and Management of the South American Tomato leafminer, *Tuta absoluta*' held on 27 September 2016 at the International Congress of Entomology in Orlando, Florida, USA.