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FranceST

The news in science and technology from France

N°89

24 April 2006

By the Science and Technology Department (STD) of the French Embassy in London
www.ambascience.co.uk

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An Extraordinary Year for a Young Company Called Quertech Ingénierie

2005 will undoubtedly be remembered as an extraordinary year for the two founders of Quertech Ingénierie, a young company that has just celebrated its first birthday as it made its move to leave Normandie Incubation for good. After winning the two most important French prizes for support to business creation in 2005, Quertech Ingénierie has again 'hit the headlines' when company cofounder Denis Busardo received the Engineer of the Year Award in the Innovation category.

Denis Busardo did his engineering studies at the then Caen ISMRA (Institut Supérieur des Matériaux et du Rayonnement, higher institute of materials and radiation), now ENSICAEN. Once he graduated, he started work on a very special doctoral thesis since it combines "both science and engineering". The object was to manufacture micro-porous membranes, i.e., dotted with very tiny, perfectly calibrated holes, for ultrafiltration. "This involved irradiating polycarbonate membranes, soaking them in a sodium bath, and obtaining micro-porous membranes. I did this work at the GANIL (Heavy Ion Accelerator) in Caen from 1986 to 1989," said the physicist tempered engineer who admits he had a lot of fun since he loves applied physics so. However, after finishing and reading for his thesis, he turned toward industry. "I wanted to solve other issues." So Denis Busardo joined the Dassault Systèmes Group in 1989. That is where he met Catia, amazing software that somewhat concentrates all the skills in industry and lets them interact. Denis Busardo's ten years on-the-job experience were very enriching. "Today, I have both a physicist's and an industrialist's outlook. While a thesis teaches you how to build an experiment protocol and embrace the scientist's intellectual approach and draft a document, a company teaches you to be within your customer's reach. It's different kind of experience with a whole different vocabulary."

All the Ingredients Needed for a Successful Industrial Project

When Denis Busardo returned to Basse-Normandie in the early 2000s, he became interested in the advances in physics, with a focus on CRS (Electron Cyclotron Resonance) sources. An ECR source is a kind of small magnetic bottle into which gas that has been ionized with HF pressure and then extracted with an extraction system to produce a high-energy beam. The source is very light (less than a dozen kilos) and last forever (permanent magnets). Now when he left the GANIL ten years earlier, this kind of source took up an entire room. "They were monsters," he exclaimed. The revolution in the field of permanent magnets cleared the way for Pantechnik, a small Basse-Normandie business, to devise very small, highly compact ECR sources. The Caen born engineer quickly realized that the sources could be used for processing selected parts of mechanical parts. They just had to be passed in front of the beam at a given speed.

"We then had to identify the best ions for this kind of application. Nitrogen was widely used. Also, I immediately realized that ion implantation was a low temperature treatment. So it should preferably be used for aluminum alloys as the melting temperature for aluminum was 660°C, which is fairly low," Denis Busardo explained. After conducting a bibliographical search on the web, he realized that aluminum alloys lacked surface treatments. With all this information, he decided to call on the authorities at Normandie Incubation. "I was hoping to meet an industrialist or a person with all the skills needed to develop the project I had in mind. It's fin to have ideas but you have to be able to industrialize them." Through the business incubator, he met Frédéric Guernalec, a forty year old who spent twenty years of his professional career in industry. He had a Masters in Science & technology in Scientific Innovation and a Masters in Economic Development and had different R & D engineering positions, ranging from Marketing Product Supervisor to Business Engineer and Sales & Marketing Executive. All the ingredients were there for a successful business project brew viz. a very promising technology on the one hand and marketing and sales experience on the other.

Giant Ican Interested in the Technology

Officially created in December 2004, Quertech Ingénierie now relies on a core of three including both founders and a third man, Guillaume Planchenault. The ENSEEG engineer is Technical Executive in charge of industrializing the aluminum nitriding machine whose industrial prototype is scheduled to become operation during the first quarter in 2006. The machine will treat either special aluminum alloy samples or the parts directly. Thanks to the prototype, the behavior of the treated mechanical parts will be qualified. Considering past results, Denis Busardo and both his partners are very confident. By implanting nitrogen ions in aluminum at depths ranging from 0 to 3 microns, they have managed to produce parts whose hardness is near or even higher than the hardness of steel. Unsurprisingly, aluminum giant Alcan is closely watching the work of the small Basse-Normandie company, which is looking at a rosy future. The nitriding technology it is developing is appealing to major industries such as cars, aeronautics and plastic processing. Not to mention that the technology is applicable to other materials.

Quertech Ingénierie's technology is also amazing because it is nothing less than a cold metallurgical process that preserves the mechanical properties of the original alloy. "Actually we are making surface alloy," underscored Denis Busardo who is very happy even though he still has a lot of work ahead. What is his recipe? "I'm having fun as are my colleagues. Of course, we're each ensconced in our own world. But for a company to work smoothly, the different worlds have to interact." That rule is apparently working out extremely well at Quertech Ingénierie.

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Plasma Physics

Plasmas with Multiple Applications

Everyone has heard the world 'plasma' at least once. The public automatically associates this admittedly esoteric word with the word 'screen'. Indeed, with neon tubes, this was the first 'consumer' application of what scientists call the 'fourth state of matter'. But aside from this use that took no less than forty years or so of intense worldwide research, specialists in the field are looking at major long-term applications in ONERA's core skills i.e., electromagnetism, aerodynamics, combustion and ionic propulsion.

"The studies we conducted at ONERA in the past had specific direction. But today we are trying to introduce the discipline into the core skills of the research establishment. This is a change in our way of working," reported Serge Larigaldie a plasma specialist at the Palaiseau Center. The Research Director at the Optics and Plasmas Unit (DOP), Physics, Sensing and Instrumentation Department (DMPH), a breeding ground for ONERA plasma specialists, has been working extensively on plasmas since he joined ONERA in 1971. At the beginning, he focused on electrostatic discharges that occur on planes, "a very tough problem that causes radio communication disturbances aboard planes," he explained. He then tackled research on lightening, sliding discharges, pseudospark plasma switches, and something called "plasma mirrors" for an ONERA backbone research project (PRF, *Projet de Recherche Fédérateur*) that got off the ground in 2003. The mirrors are actually 'immaterial' radar antennas acting as reflectors with the theoretical advantage of very fast orienting capabilities.

First Applications in Stealth Technology for 2020

"Now the activity on plasma mirrors continues in Toulouse and Palaiseau," said Gérard Bobillot, Radar Stealth Task Officer for the Director of the Electromagnetism and Radar Department (DEMR). The research is geared to orienting electromagnetic wave beams successfully through plasma, not through reflection but refraction, by modifying its parameters. Other studies are working on designing plasmas in micro-capillary columns and stacking them to make meta-materials or so-called "photon band" materials whose propagation properties are very interesting. "The materials could be used to create switchable antenna protection systems," he underscored.

At the same time as the research on plasmas for improved radar antenna protection, DEMR and DMPH researchers are also taking a closer look at using plasmas to increase the stealth of certain systems such as radomes. Two studies are ongoing. One is to design a plasma film deposited between two dielectric plates. Albeit a tough operation, if successful the outcome would be a device that could switch very briefly. The purpose of the other study is to protect the nose cone of a weapons plane. To do so, plasma has to be developed inside the radome, which means it cannot be flat but must fill the inner part of the volume completely.

ONERA is also focusing on another topic e.g., the development of plasmas in the air. "This is not a new idea. The object is to have a plane go into stealth mode by surrounding it with a plasma ball. The only - albeit huge - problem is that a colossal amount of energy is needed," summed up Gérard Bobillot. So, ONERA researchers have set a more reasonable goal of only treating certain local "shiny" points on the aircraft, which involves producing stable plasma. Thanks to a bibliographical study and a series of tests, two stable discharges in the air have been found. A test run in 2004 on a test bench produced the second discharge, which only burned several hundreds of watts along 30 centimeters. The stable discharge that radiates little light absorbs to the order of 3dB. "We are going to try and produce several discharges before reaching absorption to the amount of a dozen dB. But a lot of work needs to be done before we design an operational system," he predicted.

From Aerodynamics to Combustion

For nearly two years, ONERA researchers have been working on plasma applications in aerodynamics, supersonics and subsonics, a very tricky subject where the outlooks are also very interesting. "Reducing plane wake by roughly 10% simply means that the aircraft would be sold to the detriment of its competitors," stated Serge Larigaldie. Doing so is no easy job although the challenge can feasibly be met according to the scientist. "There are two research centers at ONERA that are studying applied plasmas in subsonic aerodynamics. One is Palaiseau that focuses mainly on developing plasma sources and understanding the physics of the phenomena. The other Toulouse-based Center is mainly seeking to use current plasma sources to modify aerodynamics," summed up Denis Packan, a Research Engineer at the DOP Unit headed by Brigitte Attal-Tretout. Tests in supersonics to lower shock-wave intensity around a mockup, by using a low power electric discharge were run in the Meudon supersonic wind-tunnels as part of collaborative work involving DMPH and and the Fundamental and Experimental Aerodynamics Department (DAFE). Overall, research is ongoing at ONERA on a PRF called PUMA that is coordinated by the Aerodynamics and Energetics Modeling Department (DMAE).

Optimizing engine combustion and specifically plane engine combustion is an ongoing concern for industrialists. One solution the scientists are looking at is to use a plasma that can broaden stability and combustion, increase efficiency and make the engine less polluting. "When a plasma discharge is applied to a flame, an intense electric field ionizes the environment, creates high energy electrons and uses a complex collision energy exchange process to produce reactive species such as radicals that can potentially improve combustion," explained Denis Packan. At ONERA several experiments in the field have been conducted to study the effect of a plasma on a CH4/air flame. "During the test, two types of so-called "dielectric barrier" pulse plasmas were successfully tested for the hookup of a diffusion flame," he explained. The goal is to seed locally the zone located under the flame with free radicals to reduce ignition time and stabilize combustion.

At the same time, ONERA teams are conducting experimental studies on simpler flame-plasma interaction situations. "Applying this type of solution may lead to appreciable engine performance gain," the Palaiseau researcher pointed out. As part of the research, ONERA has designed so-called "surface discharge" spark plugs for Renault. The application results from research on lightening that, here too, improves combustion. "This field appears as one of the most fertile in the medium term for plasma applications," remarked Serge Larigaldie.

Optimizing FEEP Technology

Most satellites now in orbit are equipped with small engines that burn vehicle-borne propellants. The satellites can correct their orbit thanks to a standard chemical propellant. The drawback of this propulsion mode is that, for a geostationary satellite weighing 3.5 tons at launch, about 300 kilograms of propellant have to be onboard for station keeping. This is a lot of propellant considering cost price for lofting into orbit a one-kilo payload. This explains how the idea of using electric propulsion aboard satellites was born. The technology provides much higher thrust performance thanks to using solar-panel generated electric energy. The fuel mass gain usually exceeds ten but thruster physics are complex and hard to control. The first studies were conducted in the Soviet Union, the United States and at ONERA in France back in the sixties. However, Soviet research led to the first satellite application in 1964. Later, Professor Alexeï Morozov's research prompted the design of a SPT (Stationary Plasma Thruster) plasma engine in the early seventies.

After the fall of the Soviet Union, numerous laboratories in the West and specifically ONERA teams working with SNECMA began work on a family of engines manufactured by Fakel, a Russian company. From 1995 to 2002, ONERA has been deeply committed to the research, specifically under a GDR (research group). "For the past two years, we have been working on another type of so-called "field emission" electric propulsion. Called FEEP (Field Emission Electric Propulsion), the engines rely on another physical mechanism and belong to a maximum thrust range of 100 micro-Newton compared to 100 milli-Newton for SPT engines. For certain scientific space missions that require a very high degree of stability we needs very weak thrusts," explained Jean Bonnet, a Research Engineer at the DOP Unit who is researching these thrusters. Although the technology is mature, it still needs to be optimized, meaning modeling and measurements. "For this type of study, ONERA's asset is that it draws on several advanced test facilities such as the B51 space simulation chamber, related thrust measurements and laser optic diagnostic means. The diversity of equipment is the outcome of the decision to get involved in ONERA's core skills, i.e., space research," concluded Denis Packan.

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Energy / The Environment

Better Performance Refrigerators for Less

In France, 37 million household refrigerators stop and start several times a day. They use the greatest amount of energy at startup, so real electric power savings can be expected by increasing the thermal inertia of the appliances. Antony-based CEMAGREF specialists in refrigerating processes are studying the design of a refrigerator-freezer combination with high thermal inertia. They opted for phase changing materials (PCMs) that can go from solid state to liquid state by storing cold in a reversible way. So, a combined refrigerator-freezer with walls incorporating 10 liters of the material could store enough energy to keep products at a steady temperature for more than 14 hours without restarting refrigerator engine. Another advantage of the process is the possibility of selecting certain operating times so as to take advantage of lower electricity rates and a self-power capability of several hours in case of power failure. From the health point of view, high thermal inertia improves the steadiness of food preservation temperatures, thus lowering the risk of bacterial development. Finally, implementing this material requires very few changes in standard appliances. At the Pollutec 2005 show last December, the CEMAGREF Engineering of Refrigerating Processes Unit whose scientists are tackling high thermal inertia of refrigerating systems received a prize for its work in 'Innovative Technologies for the Environment'.

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Epidemiology / Transportation

What Part Does Air Transportation Play in the Spread of Epidemics

What part does air transportation play in the development and spread of potential epidemics? An international team with CNRS, CEA, Paris Sud University and Indiana University researchers is working on providing an answer to this crucial question. Working from a database supplied by the International Air Transport Association (IATA) that contains passenger flows between our planet's different airports and population data on the air travel zones, the researchers developed a stochastic model (i.e., with a random variable) of epidemic propagation across the globe. They studied the role of the properties of the air transportation network (airports and airport connections) on the heterogeneity and predictability of the spread of an epidemic worldwide and used adjusted mathematic tools to quantify the phenomena. By comparing the spread through the air transportation network with epidemic spread through other kinds of networks, the scientists showed that the complexity and heterogeneity of the air transportation network are responsible for the strong heterogeneity of epidemic propagation worldwide. The team also showed that two types of heterogeneity in the air transportation network have opposite effects. One, the heterogeneity of airport size and number of connections generates hubs with numerous connections through which an epidemic may spread, thus weakening predictability. Two, the high heterogeneity of passenger flows involves preferential transmission channels which, on the other hand, strengthen predictability. This means that not only is it possible to characterize the preferential channels through which an epidemic may spread but also that the accuracy and precision of the predictions of the stochastic models commonly used in epidemiology can be quantified and understood.

Therefore, the spread of epidemics worldwide can be more clearly grasped by applying mathematical models that include the huge complexity of the underlying transportation network. However, for more realistic forecasts, numerous details have to be added to the stochastic model of epidemic spread (for instance, the effects of seasonal variations or different hygiene conditions in the different countries). The study findings clear the way and highlight the possibility of obtaining quantitative measurements of epidemic process predictability. This could be used, for instance, to get confidence intervals for epidemic forecast, risk analysis or reaction strategies.

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Gene Therapy

Gene Therapy Successful in Treating Lower Limb Arteritis

The advances in gene therapy made during the TALISMAN (Therapeutic Angiogenesis Leg Ischemia for the Management of Artheriopathy and Non-healing ulcers) study benefited 125 patients with lower limb arteritis. Initiated in December 2002, the gene therapy assessment protocol was conducted by a team coordinated by Professor Eric Van Belle and Doctor Mohamad Koussa, Lille CHRU Cardiology Hospital. The purpose of the study was to assess a treatment that could benefit several thousands of patients with the serious disease who cannot receive the usual treatments for the pathology, viz., bypass surgery or artery dilation, in the Nord-Pas-de-Calais region. Gene therapy involves an intramuscular injection of a gene that enables the local production of a factor promoting vascular growth recovery. The gene acts on artery growth through four cures at fifteen-day intervals. "This is the first time that a study has shown the success of gene therapy in the cardiovascular field," remarked Professor Eric Van Belle. Actually, study findings highlighted a 50% lower rate of amputation and death. Because of TALISMAN's success, a test on larger scale is scheduled to get started soon (late 2006 or early 2007) on 300 to 500 patients.

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Information Technology / ICT

Bayesia Now Sold in Japan

The well-known Massachusetts Institute of Technology (MIT) has ranked Bayesian networks, a computing method that revolutionizes decision making and data mining tools, fourth in the list of technologies that will radically change the industrial world. Groups such as EDF, PSA, EADS, Areva T&D, Saint-Gobain, Dassault Aviation and Orange have already adopted the computing method by acquiring Bayesia-engineered software. The small company founded by Lionel Jouffe and Paul Munteanu is the outcome of ten years of research. The Laval-based company (Mayenne *département* in western France) is the only Bayesian software publisher in France, offering uniquely relevant answers to numerous industries faced with various issues, thanks to the applications of Bayesialab, its data mining software. The perfectly easy-to-use software provides data analysis that anyone can understand, it can be installed on any operating system compatible with Java technology. The software is now retailed in Japan. The first Japanese customer of the small Mayenne-based company is the leading electric utilities. Other Japanese companies are now taking a closer look at Bayesia products, especially Bayesialab software.

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Information Technology / Robotics

Stäubli Optimizes Industrial Robot Movements

Staübli a Swiss company renowned for its connectors and components for weaving machines also designs robot arms for assembly line work. The arms are equipped with electronic controls and software for movement programming. Although programming relies on user description of the routes and manipulations the robot has to carry out, movement cycle optimization is still chiefly empirical. In other words, users have to adjust trajectory parameters such as maximum speed and acceleration depending on sought-for results. Thanks to Matthieu Guilbert's thesis supervised by Pierre-Brice Wieber and done at Stäubli under a CIFRE convention, this stage has been automated. Adjustment time is slashed, adjustments no longer require user intervention and final robot performance is improved. The result was reached by using appropriate digital optimization algorithms to improve integration of system physical constraints during trajectory generation.

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Medicine / Pharmaceuticals / Neurology

Faust Pharmaceuticals Announces Clinical Trial Results for Treatment of Amyotrophic Lateral Sclerosis

Established in 2001, Strasbourg-based Faust Pharmaceuticals is the outcome of work by six scientists from two CNRS laboratories (laboratory for cell neurobiology and the institute of natural substance chemistry). The company specializes in the research and development of drugs for diseases of the nervous system. It has just announced the Phase IIa clinical trial results of its lead molecule FP0011 in amyotrophic lateral sclerosis (ALS). ALS is an orphan disease which affects between one and five people per 100,000 worldwide according to different estimates. It causes degeneration of the motor neurons controlling voluntary movements and leads to gradual muscle atrophy. One hypothesis is that the degeneration is caused by the presence of excessive glutamate in the synaptic cleft. FP0011 inhibits the release of glutamate and has neuroprotective properties making it a candidate drug for the treatment of ALS and potentially for other neurodegenerative diseases such as Parkinson's.

The Phase IIa trial was conducted at Salpêtrière Hospital, Paris under the supervision of Professor Vincent Meininger and Doctor Lucette Lacomblez. The goal of the clinical trial was to acquire data on FP0011 patient tolerance and safety and check whether it was possible to administer the molecule in combination with riluzole, currently the only ALS treatment on the market. The trial showed that FP0011 administered for one month at doses of 60 and 120 mg per day did not modify plasma concentrations of riluzole and displayed excellent clinical and biological safety. The double-blind study was conducted on a group of 24 ALS patients. Faust Pharmaceuticals CEO Thomas Sech said, "This past year has been productive. We have completed the Phase I study successfully on a total of 62 subjects and a Phase IIa trial with FP001 on 24 ALS patients. We are now looking to carry out Phase IIb trials with the same molecule on patients with Parkinson's disease."

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Pharmaceuticals

Ipsen and CEA Launch Six Programs

CEA (French Atomic Energy Commission) and pharmaceutical laboratory Ipsen have agreed to initiate a R&D partnership. Ipsen (staff 4,000) markets some twenty drugs and dedicates roughly 19% of its sales figure to R&D. The partnership involves six joint research programs on endocrinology and neuromuscular disorders, two of the industrialist's major therapeutical fields. CEA will be bringing its expertise in several fields (medical imaging, chemistry and chemical synthesis, analytical method development, and biomolecule engineering) to the partnership.

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The Environment / Climatology

First Results for AMMA Program

AMMA, a program launched by French researchers in 2001, now brings together more than 145 European, African and American research facilities. Program goal is to gain a firmer grasp on the mechanisms of the African monsoon and predict its variations and repercussions on the local, regional and global climate and populations more efficiently. The program relies on several observation periods of all of West Africa. From mid-January to mid-February, an intensive period of observation was dedicated to the impact study of aerosols on the radiation balance (solar radiation and earth radiation) in West Africa during the dry season before the monsoon. The African continent is the biggest source of mineral aerosols and of fire-generated aerosols often generated by farming practices, on the global scale. The aerosols have a substantial impact on the radiation balance of Africa on the regional scale and therefore on planet albedo, i.e., the fraction of solar energy reflected into space, and global climate change. Aerosol diffusion and absorption reduce the solar radiation transmitted to earth and ocean surface, locally heat the atmosphere and modify the dynamics of atmospheric currents and the monsoon-related water cycle.

The first test campaign involved German (Munich University), British (NERC, UKMO, and Leeds University), Italian (CNR) and French (CNES, CNRS, INSU, IRD, and Météo France) organizations and about ten European laboratories. The purpose was to understand the effect of the West African mix of mineral and carbon aerosols on radiation and study its impact on African monsoon dynamics. The campaign was first rolled out in Niger, Benin and Nigeria to study the properties of mineral particles, i.e., those produced by fires, and their mix in the atmosphere. The campaign continued over the Dakar-Ile de Sal region. The purpose was to study the Sahel transport and export of dust over the ocean. For the campaign, huge observation facilities were deployed (satellite observations, research plane for measurements and in situ samples, and ground observation stations).

Although scientists are still analyzing the findings, the teams already have first results. For instance, 2006 has undergone fewer desert dust uplifts than other years. However, several flights of the British BAE-146 plane were instrumental in analyzing the transition zones between mineral particle source regions and burn regions. Findings show that the mix zones are not only located near the surface but also at altitude. Also, only particles produced by combustion were observed at high altitudes. Thanks to measurements taken by plane, high concentrations of combustion particles transported by atmospheric circulation combined with high concentrations of carbon dioxide and ozone were identified in a layer at an altitude ranging from three to five kilometers. Other instances of old biomass particles transported over the ocean at high altitude were also studied during the second observation phase.

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Virology

NeuroPrion Hosts Two More Industrial groups

NeuroPrion, a research platform on prion diseases (Creutzfeld-Jakob disease, mad cow disease, and so on) is set up at the CEA Center in Fontenay-aux-Roses near Paris. Over the past months, the platform has hosted the R&D teams of two industrial groups. The *Laboratoire français du Fractionnement et des Biotechnologies* (LFB) specializes in plasma-derived drugs. The company generates a turnover of €240 million and employs 1,250 personnel including 180 in R & D. LFB's collaboration at NeuroPrion involves ensuring the safety of its products and developing methods to eliminate or render inactive possible infectious contaminants, such as prions. Steris France, a subsidiary of Steris Corporation boasting 5,000 employees and a one billion-dollar sales figure, offers disinfection and decontamination technology and services for pharmaceuticals, medical devices, defense and industry. Steris France will be tackling the development of new decontamination methods that are effective against prions and can be adapted to medical and surgical instruments. The risk of iatrogenic transmission of prion diseases is a hazard during operations such as endsocopies, appendectomies and amygdalectomies.

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Materials

A Journey through HPM

The Saint-Gobain group's High Performance Materials (HPM) sector (est. April 2004) features seven core skills e.g., Grains & Powders, Abrasives, Ceramics, Crystals, Plastics, Reinforcements & Composites, and Reinforcing Tapes & Fabrics. The French group has published a remarkable travelog style brochure called Voyage en HPM (a journey through HPM) that takes readers on a round-the-world tour of its plants. The group's expertise and core skills in each country and the sector's founding vales, i.e., synergy, innovation and exchange are also featured. The brochure also comes with an exhaustive directory of the sector sites.

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