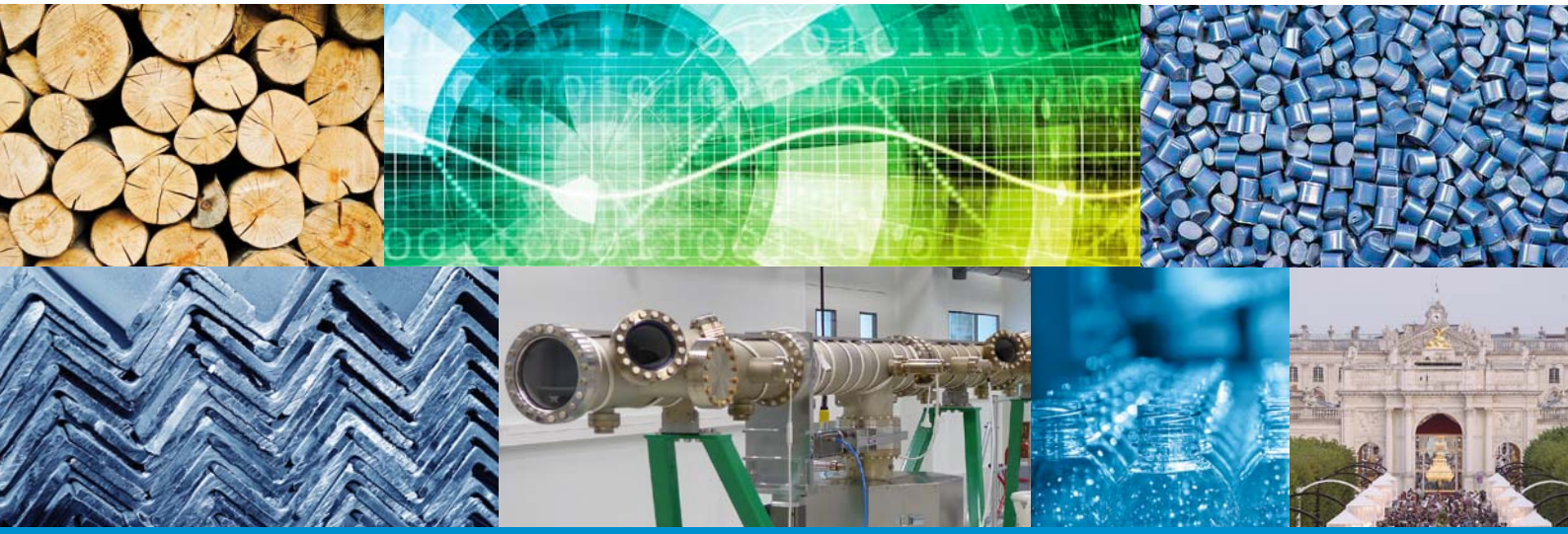
WORLD MATERIALS FORUM



OUR AMBITION, 2015 SUMMARY OF FINDINGS
AND WHAT IS NEXT FOR 2016

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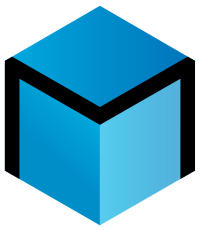

WORLD
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FORUM

WORLD MATERIALS FORUM: OUR AMBITION

The **World Materials Forum** aims at giving a unique opportunity for leading politicians, academics and industrialists from all countries to meet at the highest level in order to exchange visions and experiences on questions related to materials usage and availability.

Participants focus on assessing the present situation and trends and designing innovative solutions for the future in a world of booming demand and increasing concerns for sustainability.

2015: THE FIRST EDITION

The Forum was hosted by the President of the Nancy Council, who, together with the City Mayor reminded us that Nancy has been at the heart of European Innovation in the field of Materials since the 19th century (from Daum and Baccarat crystal works towards the recently built Jean Lamour academic research center in Nancy and Safran composites plant in Commercy).

Our 1st edition gathered the **Chairmen/CEOs** of Airbus Helicopters, Areva, Arkema, EcoEmballages, Guala Closures, I Pulse, Italcementi, Mitsubishi Heavy Industries, PSA Peugeot Citroen, Rio Tinto, Saint Gobain, Solvay, Valspar, and Voest Alpine together with **Leading Academics** from Yale, Hanyang, Denkendorf, Leiden, Ecole Polytechnique de Lausanne, ESPCI Paris, University of California San Diego/ Irvine and Lorraine University as well as top level representatives from Airbus Group, Decathlon, Nike, the NGO IUCN and the EEC funded Knowledge and Innovation Communities, as well as some founders of high tech start ups around 3 main topics :

- Theme 1 : Access to rare materials
- Theme 2 : Circular Economy
- Theme 3 : Substitutive & alternative materials for competitiveness

Workshop co-chaired by Shunichi Miyanaga (CEO Mitsubishi Heavy Industries) and Prof. Thomas Graedel (Industrial Ecology Department, Yale University)

2016: MATERIALS EFFICIENCY FOR THE 21ST CENTURY

In 2015, we assessed the impact of the expected doubling of the world middle class on the future demand of materials and we identified possible remedies to the resulting bottlenecks. As a conclusion, we agreed that this will require a new approach to materials usage that we could call **"Materials Efficiency"** or how to carefully use our natural resources while fulfilling the needs of our citizens and ensuring profitable growth for our industries.

Our 2016 edition will therefore dedicate its first two Plenary Sessions to **"Speaking with data".**

- PS1 will start with the restitution of a joint survey World Materials Forum, Bureau des Recherches Géologiques et Minières and Mc Kinsey, the presentation of a global panorama of world resources and materials - both commodities and rare materials - and some deep dive on materials that we expect to be critical in the coming 10 to 15 years. The results of the survey will then be discussed with 2 CEOs.
- PS2 will start with the restitution of a joint survey World Materials Forum, École Supérieure de Commerce de Paris and Resource Alliance and the proposal of a collection of Best Practices to assess the industry/society performance in using materials with proper efficiency. The results of the survey will then be discussed with 2 CEOs.

6 workshops split into two themes will then be held - each of them under the joint leadership of one CEO and one Academics.

- Theme 1 will be dedicated to **Technological Breakthroughs** that allow for Materials Efficiency and our 3 workshops will focus on 3D Printing, Connected Devices and Automation Engineering for Materials Processes.
- Theme 2 will be dedicated to **Continuous Innovations** that allow for Materials Efficiency and our 3 workshops will focus on Management of Plastic wastes, New materials combinations for Building/Housing and New mobility systems in order to increase car usage rate.

Finally our last plenary session will be a debate between some CEOs, and some International Political Leaders in order to try and find **the Governance Model that will support this new growth pattern less intense in materials.**

SUMMARY OF FINDINGS 2015

PART 1

Increasing pressure on the materials industry to meet booming global demand

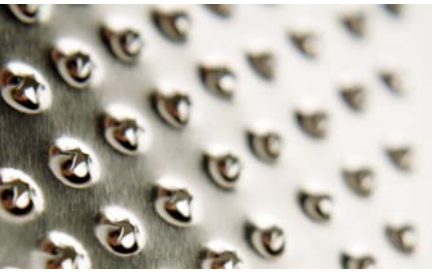
1.1. Importance of some Mega Trends - access to middle class, urbanization, connection to Internet and citizen push for green behaviors.

Shunichi Miyanaga, CEO of Mitsubishi Heavy Industries started with a good summary of supply/demand expected trends with on one side more demand resulting from the above mentioned mega trends but also less demand coming from the optimization of circular economy (usage reduction and recycling such as reducing the usage of dysprosium – only produced in China – in magnets used for raising thermal stability in car motors) and from innovative material (substitutes or more competitive solutions such as Carbon Fiber Reinforced Polymers replacing Titanium for aircraft engine fan blades cases) and on the other side more supply coming from discovery of new mines, better efficiency of existing extraction technologies and recycled materials used as new raw materials. Prof. Arnold Tukker, Director Institute of Materials Sciences at Leiden University insisted on developing the circular economy in both directions of product recycling and energy recovery in order to reduce the pressure on mining efficiency improvement and alternative materials development. He also raised the question of rebounds effects when more efficient products lead to higher other resources consumption. Prof. Eric Fullerton from UCSD clearly illustrated the problematic with the success of the Moore law that allowed the industry to double the quantity of information stored on the same surface of materials every 14 months... has also resulted in an incredible boom of energy consumption hereto that is no longer sustainable. Gervais Jacques, CCO Rio Tinto Alcan supported this with the development of their proprietary Primary Aluminum technology (AP) that has focused on equipment productivity during 30 years and that now adds an objective of low energy consumption with their new APXE technology. Christian Collette, CTO Arkéma, added to this in demonstrating that water and energy are engaged in cyclical interplay where Biomass for example requires 45m^3 per GJ vs. 0,5 m^3 per GJ for solar, 0,1 m^3 per GJ for coal/oil.... And 0,08 m^3 per GJ for nuclear. Eric Brac, CEO of EcoEmballages also gave some insight about one of the megatrends – urbanization – where cities usually recycle less – and about waste management in emerging economies – where the value for recycled materials is more attractive than in developed countries. Francois Pierlot, Industrial Director of Decathlon insisted on their objective to increase the share of eco designed products to 30% of sales in 2017 in order to cope with the citisen push to buy eco friendly products. Finally Prof. Nicola Marzari, EPF Lausanne, demonstrated that materials are key to societal well being and that the acceleration of the research to discovery and application cycle has been impressive over the last 20 years thanks to the rise of simulation science where "simulations are now so realistic that they predict the outcome of traditional experiments".

1.2. Need to produce more quantities, more green, at lower cost.

Philippe Bideau, McKinsey, explained that between 2004 and 2013, global mining productivity has declined 3,5% per annum, even after accounting for geological degradation. And this decline prevails across most commodities (1.5% p.a for copper up to 4,5% p.a for PGMs) as well as across all major mining geographies (all around 4% p.a). And the industry also faces dramatic capital and operating costs escalations (close to 37% p.a over the period for capital and above 18% p.a for operating). But he sees this as an incredible opportunity not only to embed operational excellence in companies' day to day work but also to adopt new technologies across the whole supply chain especially in the numeric field. Prof. Tom Graedel, Yale, also presented his 3 Axis approach to criticality (1.Vulnerability to supply restriction 2. Supply

risk and 3. Environmental implications) with an application to the 62 metals of the periodic table. His conclusion – supported by attending mining majors – was that By-product metals rank quite high in longterm criticality and that their recovery from ores (and long-term storage, if necessary) should be strongly encouraged. Prof. Par Weihed, Lula then gave precise examples of operational excellence through better monitoring of operations integrated with maintenance and including increased recovery of by products (Mo in copper at Aitik, gold and tellurium in copper at Kankberg). Steve van Zutphen, CEO Magpie Polymers also presented the innovative solutions developed by his SME that manufactures special resins used in standard filtration equipement for precious metal capture and recovery in refining operations (PGM, silver, copper, rare earth metals). Prof. Eric Fullerton also demonstrated that by turning ecological constraints into opportunities, eco design enlarges the size of the thinking frame, pushing the industry to have new ideas (such as fibreglass composites in planes, or aluminum for cars) and bigger ideas (such as aluminum nickel alloys, heat resistant plastics, lightweight steel, computer aided design or 3D printing). Vincent Lafleche, CEO of BRGM, believes that more minerals and metals will have to be produced over the coming 35 years than has been produced since the onset of humanity. Which means one new Pilbara system every 5 years (world largest iron ore resource in Australia with over 25% of existing resources) or one new La Escondida every year (the world largest copper mine today in Chile)... And he recommends a combination of actions to tackle this need to produce more quantities, more green and at lower costs : extend products lifetime, reduce uncessary use of resources (minerals as well as energy or water), design materials and products for easy recycling, develop human skills in emerging economies, transfer best practices etc... Prof. Frederic Villieras, Université of Lorraine gave insight into the specific situation of the EU, dependent on the importation of most metals (EU domestic production = less than 5% of the world production) and also at the forefront of urban waste recycling as well as hosting several world class mining equipemnt providers ... which is a key asset – see examples of Nickel, Copper and Phosphate processing where increased efficiency of flotation equipment with better selectivity of separation is the next step to increase recovery and grade of rare earth elements in the mining concentrates.



1.3. **The mega trends must be more precisely assessed and correlated with their impact on materials consumption in order to anticipate future balance of demand and offer including bottlenecks**

Philippe Varin, Chairman World Materials Forum called to the ownership of business leaders, academics, politicians, to think about how our societies can, proactively, match the world materials challenges of our time - in the next 15 years, an additional 2.5bn, (i.e 8 times the US population) people will enter middle-class, with the same aspirations and needs as the present 1.5bn - with the world materials opportunities – a combination of improved efficiency on existing materials, better recycling of end of life products and new materials for competitive supply of the required complementary quantities.

Dr Elizabethe Rowsell, VP R&D, Johnson Matthey presented the 4 key global drivers that they use to prioritize their materials R&D programs: 1. population growth, urbanization and increasing wealth of the society; 2. growing importance of health and nutrition and aging population; 3. natural resource constraints; 4. climate change regulations and environmental factors. One example of this approach can be found in the use of microporous materials for selective catalytic reduction of NoX for diesel engines bringing

breakthrough results in automotive emission control. Cynthia Arnold, CTO Valspar, added some other megatrends to their analysis such as : Inconsistent GDP growth acording to region, Rising end consumer engagement, or Big data management. She thinks that these megatrends add value to strong brands and to effcient technology management. Pascal Juery, Executive Vice President Solvay, sees innovation cycle acceleration itself as a megatrend ... and open innovation as a key enabler. One example is the partnership between Solvay (worldwide company) and Xstream (design SME) in order to develop an advanced predictive platform for the use of composites. Dr Dierk Paskert, CEO Rohstoffallianz thinks that the industry needs to organize for securing long term access to critical raw materials – especially as more than 2000 export barriers are setting the rules and China often dominates supply, demand and processing steps. His proposal is therefore that raw material demand for new technologies and time to market for different applications be specified through an improved exchange of information between up and downstream sectors in order to reduce risks of supply shortages and price volatility.

PART 2

Optimum path being designed to size the resulting business opportunity

2.1. Better processes to extract and transform existing resources (less energy intensive, more numeric, more investment on infrastructure, better economy of by products...)

Henryk Karas, Special advisor to the CEO of KGM presented a list of 10 technologies that should bring better processes in mining : Robotics; Internet of Things; Advanced airborne gravity gradiometer technology for mineral exploration; 3D imaging technologies; Automated drilling; Efficient shaft and tunnel boring system; Autonomous haulage; Plasma technology for increasing precious metal yields; Copper-eating bacteria; Remote operating and monitoring centres. He then made a specific focus on robotics and on SPARC, the largest civilian-funded robotics innovation programme in the world (With € 700M in funding from the EEC for 2014 – 2020, and triple that amount from European industry - € 2100M) and explained the expected improvement in operations safety and efficiency throughout the full proces from mining to mill including change to mine plans/methods and equipment fleet and configuration. Down on the conversion processes Prof. Margarethe Wiersema from UC Irvine, gave a special focus on Internet of Things and gave examples of using data for optimizing yields in steel furnaces as well as in complex multi steps processes where this data management could ultimately allow for the reduction of the number of conversion steps (Industrial Internet Consortium in the USA or Industrie 4.0 in Germany). Wolfgang Eder, CEO Voest Alpine presented the Voest Alpine way to organize for less capital intensive R&D and towards zero waste and low carbon process while using two parallel routes : this of efficient and cost optimized use and re use of raw materials, energy water and by products and this of resource balance optimization over the entire cycle life of one given product. Fabrice Domingues Dos Santos, MD Piezzotech, explained how fluorinated piezoelectric and pyroelectric polymers transform mechanical and thermal energy into electricity and can be used for sensors, actuators and memories. Combination of those materials and advanced printed technologies can solve paradigms, such as electroactive and competitive small series. Key challenge to success of such an innovative technology is to build the industrial value chain from materials to equipment suppliers and end users. Finally Laurent Frescaline, CEO I Pulse presented a new breakthrough technology that concentrates small amounts of energy to generate Gigawattlevel microsecond pulses of power at extremely low cost. This allows the development of disruptive solutions in terms of speed, capability, energy efficiency and environmental impact – example of Bmax, which offers revolutionary metal forming and welding solutions.

2.2. **Better efficiency of circular economy (KPIs identified/monitored, balance of public interest vs. private actors profitability, understanding of short vs. long term topics)**

Pierre André de Chalendar, CEO Saint Gobain demonstrated that Recycling & Recovery enable industrial groups to better secure their supply of raw materials and energy. Creating a recycling loop around materials helps to reduce external purchases and makes industrial companies less vulnerable to price volatility and volume shortages.
And he is convinced that cost savings can be realized through reduced waste processing cost and landfill cost, Progress of course varies between types of materials and range of industrial sectors. Collecting and recycling of glass bottles is for example a great success but the same remains to be done for building wastes. Quality of waste and communication with end customers are key success factors to such initiatives. Public policies are wonderful enablers but will never succeed if there is no competitive advantage per se for the private companies involved. Wayne O' Connell, CEO Carbon Conversion Technology, supported this approach even more for the recycling of tyres as 70% of Global Production of Carbon Black and 75% of Global Production of Natural Rubber is used in the Tyre Industry. But the existing waste tyre recovery model is inefficient & costly with poor economies of scale. And he offers a solution to re engineer the collection process to reduce the overall recycling costs and capital intensity. Waste separation at source and therefore involvement of end customer from the start is also the founding argument used by Luis Martin, CEO Punto Verde, to demonstrate that the greater the recycled amounts, the greater the pressure on the economy for proper outputs for recyclates and therefore the greater chance to make the recycling system profitable per se. Giulia Carbone of IUCN explained the Mission of their NGO to ensure that any use of natural resources is equitable and ecologically sustainable. She insisted that managing long and dispersed supply chain is "complicated". More and more consumer facing brands need to know where the material comes from and more specifically what are impacts caused by the initial extraction and additional transformations. And she presented the Aluminum Sustainability Initiative as a best practice supported by the entire industry along the value chain from material sourcing to the end of life options for all applications' aluminum parts. In terms of use of resources, Martin Brettenhaler, CEO Pavatex, reminded participants that the construction sector represents 40% of the total energy consumption of the EU and described their innovative solution of wood fiber insulation panels as a simple and cost effective solution to reduce energy consumption in this sector – not to forget his great idea of using the excessive vapor of the nearby paper mill to cover 2/3 of their own plant energy requirements. Giovanni Ferrario, COO Italcementi explained how value chain management raises the challenge for his industry to reconcile short term imperatives (financials, ratings... and also transformation from cement to concrete) with the very long term product life cycle (the cement industry requires long term resources availability... and offers very long term durability for its products). A balanced approach is needed, to combine short term view with value chain improvement actions, which are expected to payback on the longer term. And this balanced approach ensures both better industrial efficiency and solid brand and reputation.

2.3. **Alternative materials that substitute or complement existing offering**

So called "new materials" can cover a wide range of definitions from brand new materials such as vitrimers or new combination of materials such as metal alloys or composites made from reinforcing fibers/particles and a binding matrix (metallic, ceramic and organic/plastic) or even materials that include

high recycled content. In all cases, Carlos Tavares, CEO PSA Peugeot Citroen reminded participants that in the 20th century these new materials were usually invented to solve one problem or improve one parameter.
In the 21st century they are invented to improve several parameters and to solve apparent contradictions (better safety and light weighting for ex.). And he also insisted on the necessary acceleration to invent these new materials. Prof. Ludwik Leibler, European Inventor of the Year, presented the invention he has just been rewarded for : vitrimère, a new material half way between plastic and glass, both repairable and recyclable, light, insoluble and hardly breakable. Inexpensive and easy to produce, it could intervene in many industrial applications, including automotive, aerospace, construction, electronics and entertainment. Not to forget medical applications such as a glue capable of replacing the stitches to repair soft organs like the liver. Thierry Le Hénaff, CEO Arkéma focused his intervention on one family of new materials, plastic reinforced composites that are the biggest and fastest growing market within composites with market value of $38.3 billion and future yearly growth estimated at 7%. Challenges to composites growth and future generation composites developments were discussed on examples from automotive, aerospace, defense and sport markets. Prof. Sung Ha, Hanyang University, commented on the related preformances of the two generations of plastic composites : first thermoset (TS) for very demanding and less price sensitive applications, then thermoplastic (TP) for less demanding, high volume applications. Duncan Eldridge, President Morgan Composites explained how hybrid TS/TP structures can meet structural, impact and weight requirements in combat helmets. And he insisted on the use of computer modeling for other composite applications where safety is critical: Li-ion car batteries, fuel tanks or impact structures for satellites and trains. Olivier Cauquil, Senior Vice President, Materials and Parts Procurement, Airbus Group pushed for more focused R&D on specific themes : further developing advanced (high temperature or low melting) thermoplastic composites with additional functional properties (electrical conductivity, acoustic and vibration reduction, damage tolerance & high impact resistance, erosion resistance), improving/reducing testing as well as developing higher efficiency manufacturing process (quicker layup, rapid curing) in order to decrease costs and finally improving recyclability all along the supply chain. Finally Myron Maurer, Nike, Senior Director, Materials Innovation, Nike acknowledged that new materials such as Thermoplastic composites be a significant growth opportunity for his company. The key elements to the use of composites by Nike are the high energy return and flexural fatigue. Footwear innovation opportunities also require rapid prototyping for athlete performance insights – not to forget the importance of aesthetic options.

PART 3

New management approaches required to be successful

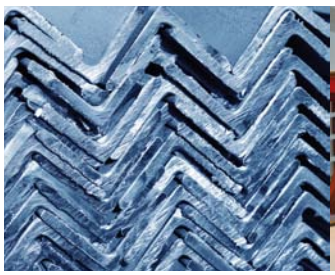
3.1. Integrated approach combining work on materials composition and sourcing, part design and manufacturing process

Prof. Sung Ha, Hanyang University, used the example of polymer composites to explain how research can be quicker and more efficient while working simultaneously on Material choices (fibers, thermosets and thermoplastics, fabrics, pre-preg products and injection molding compounds), Part design (structure and manufacturing process simulation) and Manufacturing processes themselves (mold and tool selection, processing and testing). Gilles Leborgne, CTO PSA Peugeot Citroen detailed this approach that allows Peugeot Citroen to achieve ambitious results of energy efficiency, reduced water consumption, and increased recycled content at every step of the car manufacturing process. And he insisted that the most important impact of car manufacturers efforts is to be observed on car usage performances – the new 308 that was elected European Car of the Year in 2014 weights 140kgs less with a demonstrated 20% reduction in CO2 emission and PSA is the European best performer on CO2 emissions with 110 g/km. Arun Ramchandani, VP Product & Technology

Development, Larsen Toubro, presented a thorough case study on this theme of "cradle to gate" life cycle (from acquisition of raw material to product end of life) for a Process Gas Boiler in order to anticipate and reduce impact on environment (CO2 emissions, water effluents and solid waste). An he presented striking conclusions that a reduction in boiler material weight by 5% decreaes CO2 emissions by more than 7 times than a reduction of the same boiler gas consumption by 5%. Guillaume Faury, CEO Airbus Helicopters, made it clear that the way from idea to product is complex and requires understanding of customer value as well as agility to adapt changes and simplicity to reach the target faster. The key to success is to leverage the diversity, training, inspiration and right organizational setup to create smart organizations that will come up with innovation and disruptive ideas. The Blue Edge blade of the H160 helicopter is such an example of multi research approach while simulating new part design and developing new material with the final result of fuel consumption reduced by 20% and acoustic footprints reduced by half.

3.2. **Collective works needed involving wide range of skills and actors - and even competitors or final customers -**

Jens Gutzmer, CEO KIC Raw Materials explained the EEC approach of KIC (Knowledge and Innovation Communities) that combine Education, Entrepreneurship and Research & Development initiatives in various sectors (Health, Climate, Energy... and Raw Materials). Prof. Victoire de Margerie, CEO Rondol Industrie, presented a breakthrough process development for the use of recycled materials as a raw materials for the fabrication of new composites materials. This is a new life for the well known extrusion technology based on Rondol experience with this technology in recycling complex food packaging and in embedding difficult Pharma APIs into biopolymer matrices. Screw configuration will be redesigned in order to avoid stress on critical components and the percentage of recycled content will vary either to maximize their use for existing applications at similar performance or in new applications at lower cost. And this will be a collective work involving a UK based SME supplying components for Formula 1 races, the Universities of Greenwich and Stuttgart, and a large group producing composites (Arkéma). Prof. Michael Doser, ITV Denkendorf on the other hand explained that historically materials were not developed specifically for medical applications and that it brought risks such as low biocompability, strong foreign body reaction and failure due to corrosion/degradation. The interdisciplinary approach recently developed integrates technologies while involving engineers, chemists, biologists, and pharmacologists and gave life to success stories such as new bio materials that fully replace the function of the skin and allow for fast regeneration of wounds or nerves that can be regenerated while using soft absorbable co-polymers developed without acid degradation products. Florence Ghrenassia, Director Tech Transfer APHP (Paris Hospitals) developed a similar approach to speeding up innovation in the field of medical applications while building bridges, breaking barriers and crossing skills including those coming from sectors that seem quite far away such as electronics or software games. Frank Bournois, Dean & COO ESCP Europe, presented a top down - strategy to execution - approach based on Collaboration (sharing, trust and creativity towards a clear ligne of sight), Cooperation (seeking out experts,competence put in common and commitment to project goals) and Coordination (focused on achieving stated goals). He also made a specific point on another "C" - Competing - that can be viewed as a power oriented mode of collaboration.



3.3. **Innovation on governance of public-private schemes towards more efficiency, transparency, accountability, and of course at international level**

Alan Davies, CEO Rio Tinto Diamonds & Minerals, listed the policy fundamentals for the 21st century as : free trade, anti bribery & corruption rules, environmental and social progress and adaptation of global principles to fit for purpose at local level as well as all possible public and private support to exploration as resources get harder to find and more complex to access. Marco Giovannini, CEO Guala Closures, raised the question of stimulating or rewarding "Virtuous" producers vs others especially when sustainability regulations only apply in certain regions of the world. Cynthia Arnold, CTO Valspar reminded participants that the US industry has not traditionnally interacted with regulators. And she thinks that involvment of these regulators is key to more efficient win win public – private schemes. Jens Gutzmer, CEO KIC Raw Materials gave the example of the EEC and explained that exploration and raw materials resource assessment is a key priority of his consortium that gathers 116 partners in 22 EU countries. Gwenole Cozigou, Director Industrial Transformation and Advanced Value Chains, European Commission, insisted that innovative governance of public- private schemes towards more efficiency is at the heart of the EEC programs – KIC as well as H2020 research funding priorities. Moyo Kamgaing, Group Head of Investment Banking at Ecobank also explained that Africa accounts for 30% of the world's reserve and production of 60 metals and minerals and that only 16% of these untapped resources have acquired exploration licenses hence the need for better organized public-private partnerships.

CONCLUSION

A new deal is probably ahead to make this huge quantity of "green" materials available at affordable cost for this much bigger global middle class. This will require more efficient processes throughout the value chain from mining to recycled packaging, transportation and building parts. This will also mean using those recycled materials as new raw materials for certain applications and finding other innovative material solutions for other applications. And to make all this happen at the necessary speed, Philippe Varin suggests that **new public actions** could be started such as moving away from an unefficient Emission Trading System for CO2 and rebalancing taxes with more on the 3rd Adam Smith factor (land) and less on the first 2 ones (capital and labour). Wolfgang Eder and Giovanni Ferrario advocate for **global regulations along the value chain** so that resource intensive industry investments move away from just product optimization towards high risk projects that can be sustainable only in the far future. Shunichi Miyanaga proposes to create a "**global open innovation network**" in order to overcome the problems resulting from different technology levels and environmental regulations between countries and regions. **Involvement of end users** is also fostered by Pierre André de Chalendar, Eric Brac, and Luis Martin as a way to go quicker and better. Speed is also at the heart of **new modes of collaboration** pushed by Alan Davies, Carlos Tavares, and Guillaume Faury. And Prof. Victoire de Margerie reminds that **recognition from the financial community** is key so that "good" players in terms of environmental footprint also get their efforts recognized in their stock price. For our **World Materials Forum 2016**, one thing is clear : we need to work and better understand these famous megatrends and their correlation on future materials consumption figures. So that we can design efficient initiatives both at public and private levels.

NOTES

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