

WORLD MATERIALS FORUM 2017 – SUMMARY OF FINDINGS

Introduction

The World Materials Forum provides a unique opportunity for leading politicians, academics and industrialists from all countries to meet at the highest level to exchange their vision and experience as well as to design and implement solutions on all questions related to materials *efficiency* in a world of booming demand, fundamental technology changes and increasing concerns for sustainability.

The 2017 edition focused on boosting materials efficiency and stimulating a sustainable growth while creating value for all involved stakeholders.

Taking part in the 2017 event were the Chairmen/CEOs of **Arkema** (France), **BRGM** (France), **Ecotitanium** (France), **EIT Raw Materials** (Germany), **Faurecia** (France), **FPT** (Vietnam), **Granges** (Sweden), **Imerys** (France), **Ivanhoe Mining** (Canada), **Mitsubishi HeavyIndustries** (Japan), **Puretech** (Canada), **Pyral** (Germany), **Sapa** (Norway), **SaintGobain** (France), **SmithGroup** (UK), **Solvay** (Belgium), **SpecialChem** (France) and **Suez** (France), together with leading academics from **Hanyang** (Korea), **Leiden** (NL), **EPFL** (Switzerland), **Suzhou Institute of Technology** (China), and from the 3 Top Californian Universities: **Stanford**, **UC Irvine** and **UC San Diego**.

The event was hosted for the 3rd time in Nancy by the Chairman of **Nancy Eurometropole** and by the Mayor of **Nancy**. An Indonesian delegation led by the Mayor of **Surabaya** also joined the debates as well as a delegation from the **EEC** led by the DG Environment.

Top executives from **Airbus**, **Arthur D Little**, **CRU Consulting**, **Hexcel**, **McKinsey**, **PSA**, **Rio Tinto** and **Volvo** also participated, as well as 14 startups from Belgium, France and the USA who had been nominated following a rigorous selection process a few weeks before.

Together with the World Materials Forum **Steering Committee**, they worked to answer four main questions:

1. Based on forecasted booming demand linked to well-known trends of urbanization, electrification, digitalization and expansion of middle class, how can we anticipate and minimize the impact of expected volatility of raw materials linked to technical, political or economic factors?
2. Following the 2016 edition in which we defined materials efficiency as using materials less, longer and smarter, how can we measure and monitor progress on materials efficiency with a simple set of KPIs that could be used by all industrial companies?
3. What are the potential practical and actionable solutions to improve materials efficiency while using new technologies in the field of lightweighting, recycling, Internet of Things and mobility?
4. How and when should norms, standards and regulations be developed on top of voluntary initiatives in order to speed up the adoption/implementation of these solutions.

Session 1 – Update on world status and trends for critical raw materials

In 2016, the WMF had concluded that there was “no risk of shortage of raw materials, either bulk or critical”. Nevertheless, price “fly-ups” are likely to occur for some materials due to temporary or perceived imbalances in supply and demand.

WMF 2017 was an opportunity for **BRGM**, **CRU** and **Mc Kinsey** to deep dive on social factors, emerging technologies and financing trends that impact these imbalances in supply and demand.

Social trends are the greatest drivers of demand changes and policy decisions will trigger the pace of implementation while sometimes creating “fly ups”. New legislation can have a strong impact on prices: for example, nobody noticed in 2016 that China had decided to restrict coal mines from operating more than 250 days until met coal prices started rising 3 months later when stocks were empty. Regional instability could also have a large impact on some commodities. For example, Katanga Province in the Democratic Republic of Congo 59% of the world's cobalt, that is needed in many modern applications from superalloys in the aeronautics industry to rechargeable batteries.

Emerging technologies can significantly raise demand, requiring significant investment and at the same time they can also reduce the size and duration of “fly ups” through quicker discovery or **optimized asset management**.

For example, the copper market is expected to remain in a delicate balance between supply and demand with demand for electric cars projected to rise nine-fold by 2027.

Ivanhoe explained that all electric cars now use four times more copper than conventional gasoline-powered ones. And future electric vehicles could use much more - such as the new Tesla Model 3. **And renewable energy installations are even more copper intensive, using up to 37 times those for conventional energy generation.**

So significant investment is needed to meet future demand. But technology can also help smoothen the pressure: some technologies can accelerate the cycle of minerals discovery such as I Pulse that allows for churning 3 times the area and 3 times the depth compared to existing solutions and better predictive maintenance thanks to IoT can help to mitigate the duration and the intensity of “fly ups” by increasing mining productivity and hence postponing the need to invest in new mines.

Financing should be a stabilizing factor... But a decline of public efforts in maintaining a geological database, waning investments in exploration and in new mines (down 56 % between 2012 and 2016), together with an overemphasis on exploration for gold (46% of global mining investments) increase the likelihood of extended supply deficits and price increases in the coming years.

Cooperation between all stakeholders is therefore key to optimize the size and timing of investments. And new business models like upstream or downstream integration are also an option such as Imerys on natural graphite.

Session 2 – Which KPIs can generate more growth and create more value with less materials?

In 2016, the WMF had concluded that Materials efficiency implies the use by industrial actors of Key Performance Indicators capable of monitoring their progress on the route to decoupling use of materials from economic growth while creating value for all stakeholders involved.

In 2017, 4 in depth data analysis were performed in the transportation sector and presented at the Forum by **Airbus**, **Arthur D Little**, **Granges** and **Solvay** so that the proof of concept of 8 KPIs is now validated:

- 6 KPIs for all actors of the value chain

3 in Use Less: Buy to Use, percentage of recycled materials made into new products; percentage of end-of-life recycling

1 in Use Longer: product life time including retrofits

2 in Use Smarter: percentage of innovative materials used in new products; and product performance vs weight

- 2 KPIs for producers of final products

1 in Use Longer: resale price

1 in Use Smarter: full product usage.

Beyond Use Less and Use Longer, Use Smarter was deemed crucial by all speakers: for example, tracking performance vs weight rather than just weight (example of **Airbus** showing fuel saving improved by 20% while weight increased by 10%).

Next steps should involve all industrial sectors outside transportation (building, electronics, packaging, infrastructure) for an in-depth data analysis so that final KPIs can be presented at WMF 2018. And speakers also proposed to extend some KPIs such as:

- applying Use Less to other resources like energy and water (**MHI**)

- creating a new KPI at enterprise level: EBITDA/tonnage of incoming raw materials (**Solvay**)

In 2018, industrial stakeholders as a whole could use these KPIs to further enhance their constructive dialogue with regulators.

Session 3 - From Light weighting or Recycling to Light weighting and Recycling

In past decades, light weighting was encouraged mostly for long life time products like aircraft, whereas recycling was considered mostly for short life time products such as packaging. Over the last 20 years, two new trends have appeared:

- cars and smart phones are becoming increasingly lighter, but they come in huge volumes at the end of their lives and the complexity of their multi material structures make them uneasy to separate

- both light weighting (as for aircraft) and recycling (as for packaging) seem to approach their limits every year.

Potential ways to shifting to the new paradigm of lightweighting AND recycling were presented and included:

- a new process to design and produce according to the principles of circular economy. For example, assuming that there will be 1 million tons per year of wind rotor blades at end-of-life from 2030 onwards, **Arkema** has developed a new resin allowing the blades to last longer with a more efficient manufacturing process that facilitates their further recycling. **Sapa** and **Pyral** also explained that Aluminium, on top of its well-known lightweighting potential, allows to promote a cradle-to-cradle approach with 70% of all aluminium ever produced still in use.

- considering waste as a potential resource in sectors where lightweighting was the only objective so far. This is the case in the electronics sector where 70% of products end up as trash. To give an example, one million smartphones that are dumped contain 16,000 kg of copper, 350 kg of silver, 34 kg of gold, and 15 kg of palladium. And this is also true for aeronautics where most materials have a buy to fly ratio of one for ten with scraps sold at

very low-price due to the loss of aeronautic properties. At **Ecotitanium** new Ingots of aeronautic grade are now made thanks to dedicated sorting and proper recycling technology (4.000 t expected annually at full plant maturity).

All speakers also concluded that cooperation between all stakeholders is key to find easier solutions at lower costs and that regulators have a huge responsibility to support sustainable initiatives from the industry and move from regulation or market to regulation and market (see session 8).

Session 4 - World Materials Forum Societal Presentation 2017

Faced with rapid economic development, the **Mayor of Surabaya** presented a series of campaigns and projects that she designed and implemented to transform Indonesia's second city into a green one while mobilizing community participation in all aspects of the project and with a strong focus on education. Her presentation focused on 5 main initiatives: 1. Producing a living environment; 2. Greening the city with green belts and municipal gardens; 3. Flood prevention and control; 4. Cleaning the city (managing waste); and 5. Fire control and housing. The results are a strong reduction of waste production (up to 60%) and a high level of satisfaction of inhabitants (close to 90%).

She demonstrated the crucial role of mayors of big cities in driving materials efficiency especially in the areas of waste management and mobility systems.

Session 5 - From ownership to mobility services for better materials efficiency

Speakers all agreed that paradigm shift to mobility as a service is the best response to meet increasing demand for mass transportation in terms of cost and environment footprint. This shift will specifically represent a major improvement in materials efficiency as it leads to a higher asset utilization of cars, and reduces the need for new infrastructure. And evolving car technologies (Connectivity, EV, AD) will also result in a shift in materials used.

Faurecia reminded participants that this especially true for fast growing dense, urban areas where authorities have to overcome three challenges: traffic congestion, accidents creating death or injury, and environmental pollution (including noise) to ensure a seamless mobility for their citizens and demonstrated that a combination of scrap reduction, recycling, additive manufacturing and better equipment usage can bring as much as 20% cost and materials savings.

Smarter Materials in terms of reduced degradation of shared car interiors were also presented by **Special Chem** (scratch resistant technology for talc filled polyolefin's) and **Volvo** (Autonomous Driving with no steering wheel).

As far as EVS, no real conclusions could be drawn on materials efficiency at this stage beyond the obvious positive impact on CO2 emissions (weight and life duration of batteries remain a clear area for improvement).

Session 6 – Internet of Things & data analytics for new materials solutions

Materials Efficiency through IoT started with efficient and smarter digital manufacturing (50% of product defects could be averted) and was the subject of WMF 2016.

In 2017, **Smiths Group** detailed the focus on IoT - and resulting Data Analytics - in order to promote new product designs that make better use of materials, and more efficient materials that will lead to faster economic activity.

PSA estimated to 15 to 20% the reduction in functionalities for new vehicles following a better understanding of vehicles usage thanks to IoT. And 20 to 30 % less time should be spent in new vehicles testing sessions as well with further impact on materials efficiency.

Puretech demonstrated that using advanced metering infrastructure and smart sensors, can extend infrastructure life time: knowing that 70% of replaced water pipe still has remaining service life, they offer a combination of inspection and monitoring "to assess and address" rather than a "total substitution" allowing to simply divide by 2 the cost of replacement - and the subsequent need for new materials. An interesting value proposition when the pipe infrastructure funding gap just in the US is estimated to \$ 1 trillion over the next 25 years.

So IoT is now touching every sector and is having a significant impact on how companies and consumers interact with machines and devices and therefore use materials.

[Session 7 - World Materials Forum Scientific Presentation 2017](#)

An area of significant technological importance and fundamental research involves materials formed from both inorganic and organic components that - unlike traditional composites - are engineered and fabricated at molecular dimensions.

By playing with the design and the processing of such systems, **Prof. Reinhold Dauskardt** demonstrated that inexpensive materials solutions can be found that also provide exceptional toughening, strengthening, elastic, thermal, and electrical properties.

Some examples such as silicon substrates with functionalized pore surfaces and further polymer filling seem particularly promising where such materials are used as functional layers or coatings in a variety of demanding applications in the field of electronics, aerospace and even healthcare.

[Session 8 - Which Norms, Standards, Regulations and Voluntary Initiatives for Materials Efficiency?](#)

Speakers reminded the audience that the world expanded 10-fold over the last 35 years, and is now 1,000 times bigger than it was 105 years ago.

To further sustain the growth means "life-cycle thinking" with Using Less, Longer and Smarter at all stages - **Saint Gobain** is aiming to reduce by 50% the non-recovered internal waste by 2025, to incorporate 30% of cullet in the manufacturing of flat glass for windows and 40% of it in the manufacturing of the glass fibers for insulation - but this requires and will require a tremendous financing effort, and today there are not always viable downstream market to sustain such investment - **Suez** gave the example of plastics recycling when oil price is below 50 \$ and this in parallel with the EU directive-(94/62/EC & 2004/12/EC) that sets the recycling target for plastic packaging to 55% by 2025 while the recycling rate is stagnating at 22,5% today.

Voluntary initiatives are needed and political oversight is requested to drive consumer behavior with proper Eco brands, labels and standards whether at local, regional, national and continental levels.

Appropriate economic signals for CO2 and/or landfill disposal will also be key to accelerate the circular economy.

Finally as demonstrated in Session 3, transforming waste into raw materials will require stringent specifications (e.g content in heavy metals) to be decided by regulators.

World Materials Forum Start Up Challenge

For this 1st edition of the WMF Start Up Challenge, 35 applications have been received from around the world (Belgium, China, Finland, France, Germany, Italy, Norway, Spain, USA), and the jury met at ESCP Europe in Paris on March 24th to nominate 14 candidates. Each nominee was offered a « package » including a booth in Nancy on June 29th and 30th, the professional shooting of a video to be further used for promotion purposes as well as a full coverage of registration, accommodation and transportation costs for his or her CEO.

3 Awards were announced during the Forum and went legitimately to companies that fitted the best with the WMF objective of decoupling materials consumption from sustainable growth while creating value for all involved stakeholders. The winner of the 2017 Grand Prix will be a member of 2018 Start Up Challenge Jury.

The **GRAND PRIX** was awarded to **CITRINE INFORMATICS** a Californian Start Up based in Redwood City. Its project uses artificial and predictive intelligence technologies to enable a 2-5x acceleration of materials development processes.

The « **COUP DE CŒUR** » was awarded to **SEPION TECHNOLOGIES**. This Californian Start Up based in Berkeley produces a longer lasting ion lithium battery (600 kms range) at equitable price thanks to new membrane technology that allows for no more crossover of undesirable ions across the battery separator.

The « **PARTICIPANTS AWARD** » was given to **KEYE AEROGEL**. This French Start Up based in Mulhouse has developed a high value valorisation of silica containing Construction and Demolition Waste for energy-efficient buildings, by their integration as aerogel materials with only 15% of the thickness required for the same thermal insulation factor.

The other short-listed candidates were: **3D MATTER** (Brooklyn, New York), **Aerosint** (Liège, Belgium), **Carbios** (Clermont Ferrand, France), **CYCLADEX** (Carson City, Nevada), **GENES'INK** (Aix en Provence, France), **NANO3D** (Corvallis, Oregon), **POLNOX** (Lowell, Massachusetts), **PRIMO 1D** (Grenoble, France), **SARATOGA** (Berkeley, California), **VAPORSENS** (Salt Lake City, Utah) and **WOODOO** (Paris, France).

CONCLUSION:

WMF Chairman thanked all participants for their active and constructive contributions and announced that WMF 2018 will be in Nancy on June 28 & 29.

In a preliminary program, strong focus will be given to extending the KPI approach to all sectors beyond transportation and make the entire industry use them in their future discussions with regulators. Trends on Critical Materials will of course be presented as well as Practical and actionable solutions to progress along the routes of Using Less, Longer and Smarter especially in the field of Electronics and Building. Special attention will also be given to Big Data as the need emerges to optimize between further use of Data to improve materials efficiency and prioritization requested in order to lower energy consumption requested for data storage and processing.