Critical materials within Semiconductor industry

Pascal ROQUET



May 2019











STMicroelectronics 3

- Among the world's largest semiconductor companies
- Serving over 100,000 customers across the globe
- 2018 revenues of \$9.66B, with year-on-year growth of 15.8%
- Listed: NYSE, Euronext Paris and Borsa Italiana, Milan
- Signatory of the United Nations Global Compact (UNGC), Member of the Responsible Business Alliance (RBA)





- ~46,000 employees worldwide
- ~ 7,400 people working in R&D
- 11 manufacturing sites
- Over 80 sales & marketing offices



As of December 31, 2018



-

Research & Development

 \bigcirc

- Main Sales & Marketing
- Front-End
- Back-End



Where You Find Us 5



Making **driving** safer, greener and more connected

Enabling the evolution of industry towards smarter, safer and more efficient factories and workplaces





Making homes & cities smarter, for better living, higher security, and to get more from available resources

Making everyday things smarter, connected and more aware of their surroundings





Flexible & Independent Manufacturing

6





Microelectronics is about ...



Integrated circuit



Chip with connection

Back-End



Chip without connection

Front-End



Wafer containing x000 chips





4x4 µm²

metallization 500x500 nm²













Sustainability is about....

Creating value and minimizing risks through effective management of economic, environmental and social impact to ensure long-term business success.

Creating business values

- Developing leading responsible products for an augmented life
- Promoting high standards of integrity and business conduct
- Effective governance of our strategies and ambitions

Engaging and developing people

- Ensuring health and safety at work
- Respecting and promoting people rights
- Developing competencies and diversity





· Supporting customers, investors and suppliers

- Effective supply chain to serve all customers, minimizing execution risks and impacts
- Taking into account the environmental, social and economical impacts in our decisions
- Reducing water, energy and chemical consumptions for continuous efficiency improvement



ST Sustainability Strategy

We conduct our business responsibly to create value for all stakeholders



TOGETHER, WE SHAPE THE FUTURE Supply Chain Responsibility, Education & Volunteering





Materials in Semiconductor Industry





FE & BE materials are concerned

• Front-End:

- VDP Targets
- Tungsten Gases (WF6)
- Special products (TBTDET*)

• **Back-End**:

- Device Metals
- Grid arrays
- Wires
- Lead frames
- Ceram Opto. materials







* Tert-Butylimido Tris(DiEthylamino) Tantalum

Critical materials



Criticality assessment of raw materials for EU

Elements (Selection)	Main WW producers (average 2010-2014)	Dependency rate to importation	Recycling rate for End of Life materials	Usage in Micro- elec. ?	Critical for Micro –nano elec.
W	China (84%); Russia (4%)	44%	42%	Yes – Front End CVD & ALD (WF6; Targets)	Conflict Minerals
Pt	South Africa(83%)	99.6%	14%	Yes	
Hf	France (43%); US (41%); Ukraine (8%); Russia (8%)	9%	1%	Yes - Front End (ALD : HfCL4)	
Со	DRC (64%); China (5%); Canada (5%)	32%	0%	Yes	Responsible sourcing program
Ga	China (85%; Germany (7%) Kazakhstan (5%)	34%	0%	Yes – As Ga (RF; IOT); GaN/Si devices	
In	China (57%); South Korea (15%); Japan, (10%)	0%	0%	Yes (Materials III/V InP, InGaAs)	
Та	Rwanda (31%) – DRC (19%); Brazil (14%)	100%	1%	Yes – FE Targets	Conflict Minerals
He	US (73%); Qatar (12%); Algeria (10%)	96%	1%	Yes FE fabs	Supply critical issue
Ge	China (67%); Finland (11%); Canada (9%); US (9%)	64%	2%	Yes – Tech node 7nm	



• Nota : assessed as non critical : Ti, Cu, Li, Au, Ni, Al, Sn, Se, Te, Si



Main contributor countries supplying critical materials







Helium a critical gas for Semi.





Helium supply risk 19

- Helium is a rare molecule used in MRI [*], military & aerospace, optic fiber, lab (ie CERN), and Semiconductor industry
- Helium is coming from Natural Gas, so dependent on worldwide economy (energy consumption)
- Helium cannot be stored massively and long term (except underground)
- Offer & Demand are almost balanced since years, with demand increasing ~3.0%/Y, and offer declining until 2021 (BLM effect)
- BLM [**] used to be the unique underground storage, with massive reserve, but supply is ramping down and closing in 2021
- Qatar supply (~30% of WW offer), is at risk since June 2017, due to diplomatic issue btw Qatar & Saudi Arabia
- The last two worldwide crisis (2012-2013 & 2017), put the entire world close to shortage

It is strategic to reduce risk of supply discontinuation, because a structural shortage is predicted in 2019-2021



Helium sources in the world



In the future ...

- Qatar will become the source #1
- > US will decline to #3 when BLM will close
- Siberian source will bring Russia #2

In 2017...

- ✓ USA remains leader on the market, with 50% of the market
- ✓ Africa & Middle East represents 45%, out of which Qatar ~30%





Main sources availability



21

Semiconductor weight inside Helium market...

- Biggest size of Semiconductors manufacturing plant is 20 ISO/yr.
- Medium size MRI [**] manufacturing plant is 20 ISO/yr.
- Biggest size MRI manufacturing plant is 50 ISO/yr.
- ESA (Arianespace) in Guyane is 50 ISO/yr.
- Worldwide Helium market is + 7.000 ISO/yr.



=> Semiconductor market is very demanding in purity, but relatively small in market share (<20%)

[*] ISO is a large insulated container of liquid helium, containing 26.480 m3 of helium (usable charge)

[**] Magnetic Resonance Imaging





Product Stewardship



Product Stewardship

Our Sustainable Technology program aims to develop responsible products which

- improve our social and environmental footprint at every stage of the product life
- have the greatest positive impact on the planet and people in the end-application



Our approach .



life.auamentec

Social compliance: free of Conflict Minerals 26

- We require our upstream supply chain to identify the origin of the 3TG (Tantalum, Tin, Tungsten and Gold) metals we are using in our manufacturing.
- This is to comply to the US Dodd Frank July 2010 legislation. It requires companies operating in the US to demonstrate that their products do not contain 3TG that are sourced from mines operated by armed groups in conflict zones (mostly in Democratic Republic of Congo).



Percentage of ST products which are conflict free





How to reduce our impact?

Regulation

Eco-Design

- Eco-design assess the environmental impacts of products during design phase to minimize it
- Responsible Applications
 - Identify products that augments Responsible applications

Proactivity

- Low-carbon product
- Power-efficient product
- Planet-friendly application
- Human-welfare application



Overview of the process

- Sustainable Technology program is part of Product Development Process (PDP)
- Eco-design process is applied:
 - At early stage of the design before "New Product Request" (before design phase)
 - Consolidated at "Product Qualification Certificate" (before mass production phase)





Eco-design assessment

- For every new project, R&D teams have to assess few key parameters to evaluate the future impact of the product.
- It helps to identify:
 - Power-efficient products (consuming less electricity)
 - Low-carbon products (reducing the manufacturing footprint)



 Eco-design assessment aims to increase consciousness of project teams on their contributions (depending of their choices) on the final product impact.

Product eco-design assessment

Compare vs predecessor or competitor:

Does ST chip demonstrate power efficiency in one of the following areas?

- Efficiency in power consumption of ST chip
- Efficiency in power loss of ST chip
- Efficiency in power dissipation/consumption of the total electronic system the ST chip is included

Compare vs predecessor or competitor:

- Reduction in number of metal layers?
- Reduction in number of masks?
- Reduction of die size?
- Reduction of interconnect size?
- Reduction of package size?
- Integration of features?
- Increase of wafer size?
- Reduction of wafer thickness?
- Substitution of gold or lead?
- Reduction of interconnect size?
- Increase of ECOPACK grade?
- Increase of product lifetime?
- Other optimization?



Responsible products 30

• We declare responsible products, in Environmental or Social domain, as soon as a product is demonstrating eco-design achievements or enabling a responsible application.



- Every year we report externally to investors and rating agencies ST revenues generated by Responsible products.
 - 2025 goal is to reach 30% of revenues from responsible products



Program covers the life cycle of ST products







Questions?

