

The Critical Raw Materials Act: Gallium

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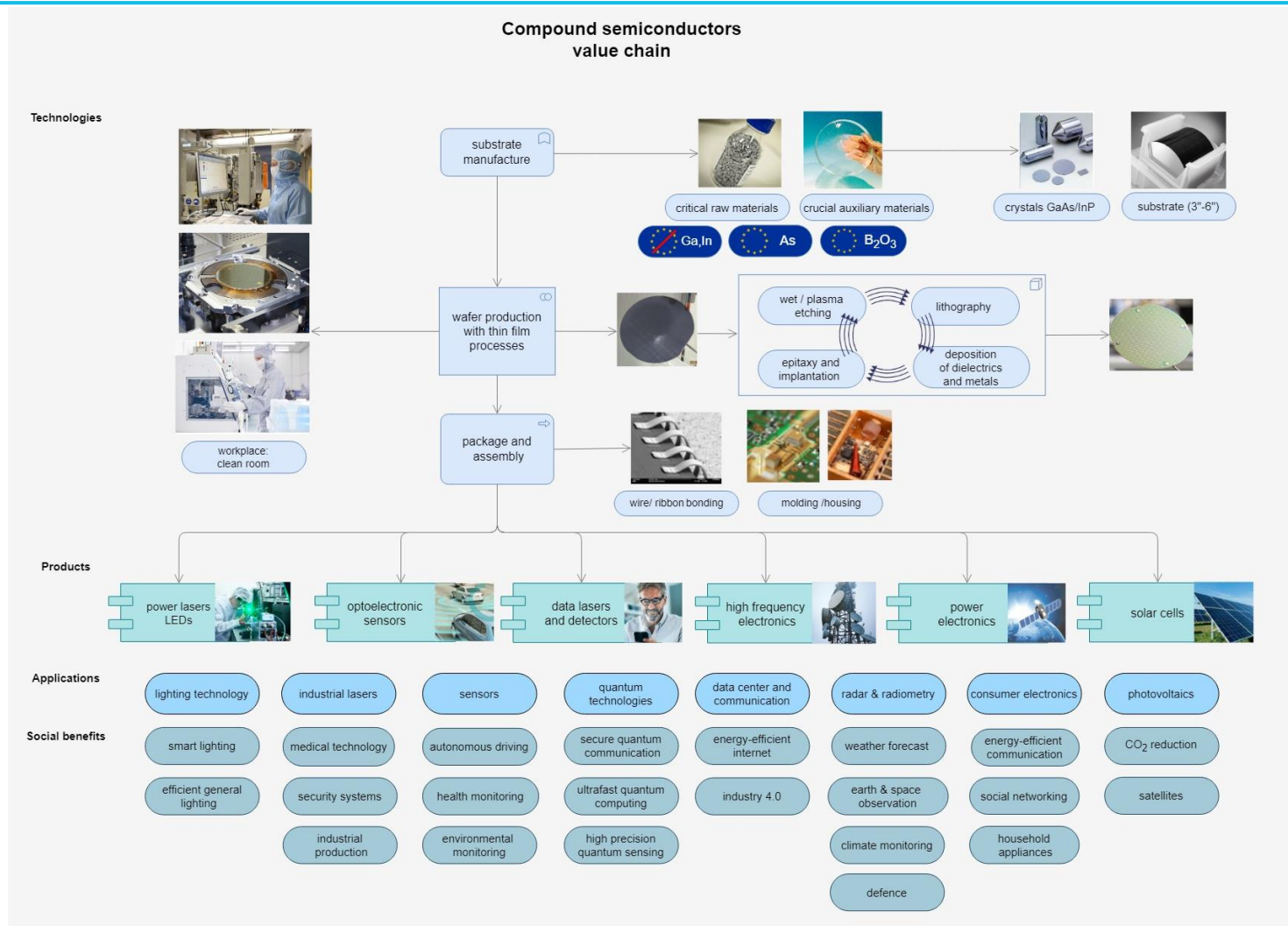
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2. Critical Applications – Gallium-X (GaAs/GaN)
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Supply Risk Material



Introduction of IMAT e.V.



GaAs enables high Technology

Wireless Devices	Smartphone PA	WiFi	Defense and Space
			
Opto-Electronics	LASER	μ LED Displays	LED
			

GaAs enables future Technologies

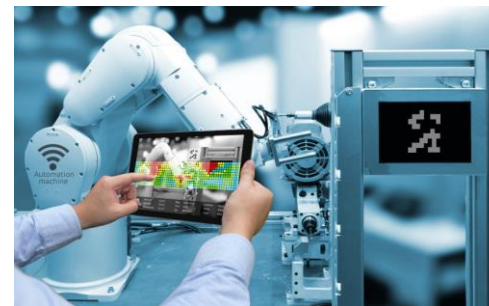
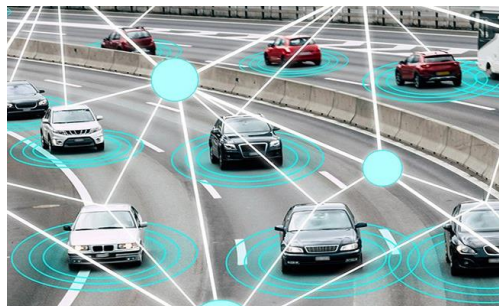
Quantum computing



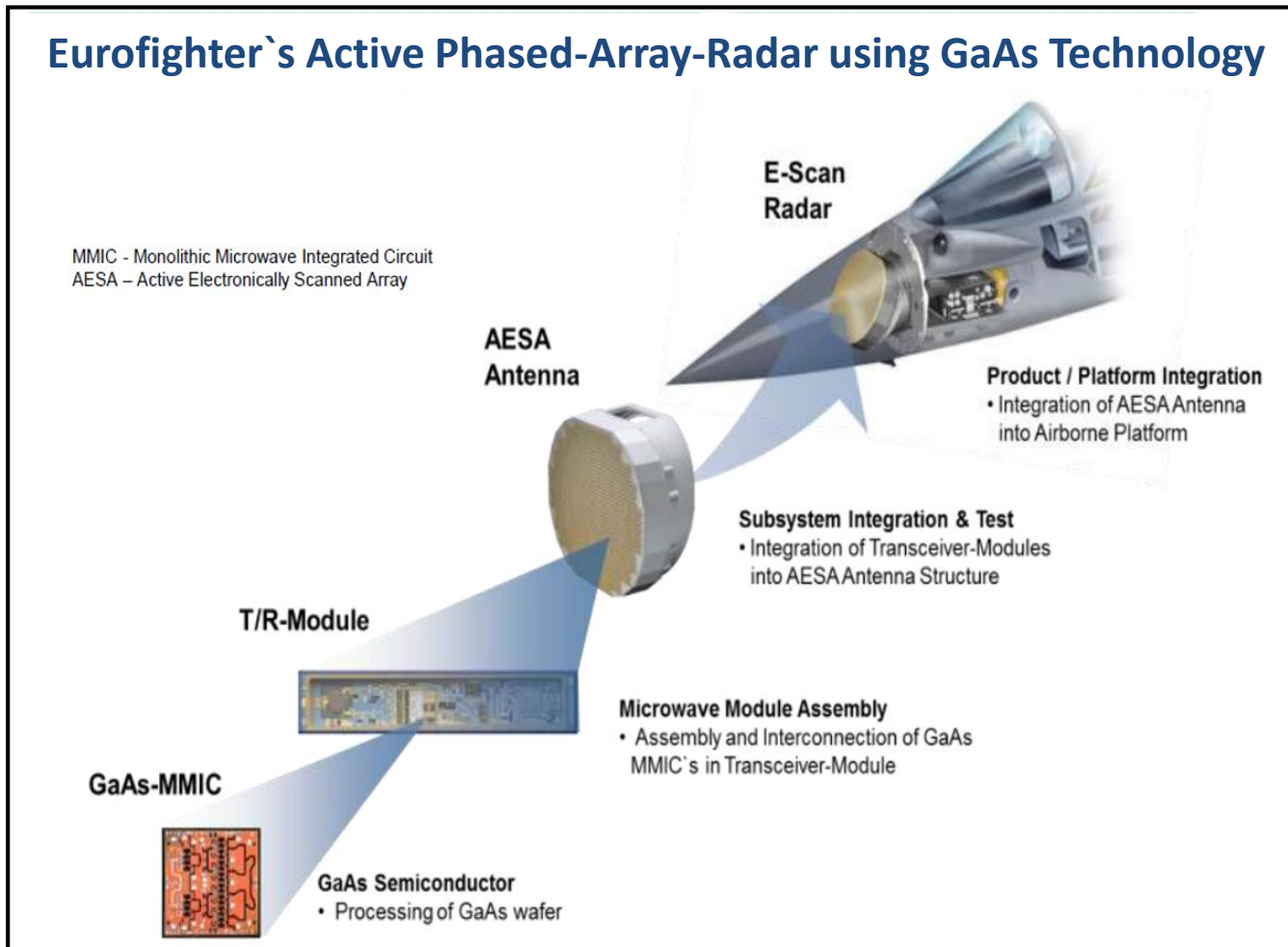
Autonomous driving



Augmented reality



GaAs enables Defense Technologies



GaN – Opto-Electronics / Power Electronics

GaN RF Power Electronics



EW(Electronic Warfare)/IED(Improved Explosive Device) jammers



Electronic countermeasures



Military radar

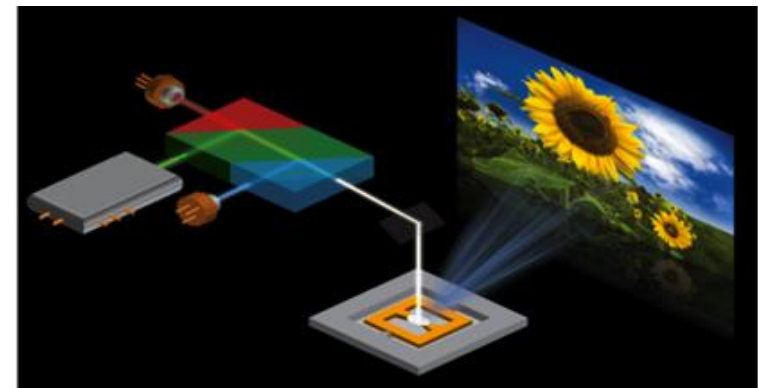
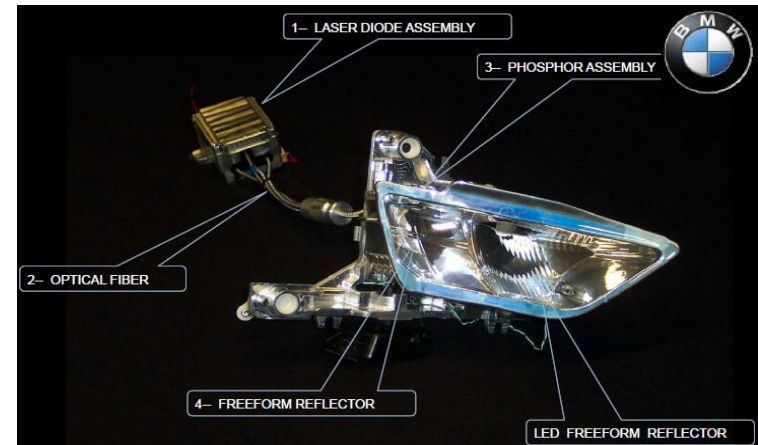


Military communications

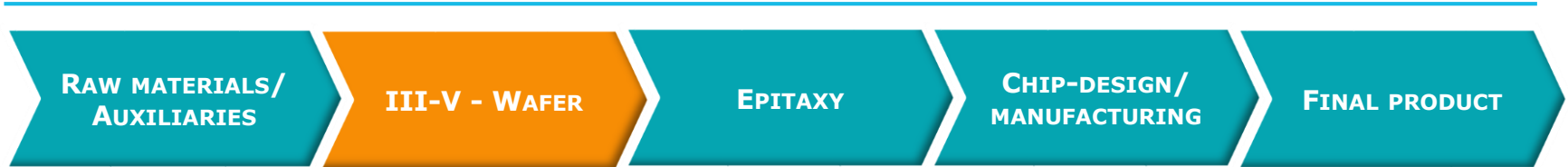
PS – Short Range Wireless Communication
The most advanced PS available on the market



GaN blue/green LASER



GaAs Supply Chain



RAW MATERIALS/
AUXILIARIES

III-V - WAFER

EPITAXY

CHIP-DESIGN/
MANUFACTURING

FINAL PRODUCT

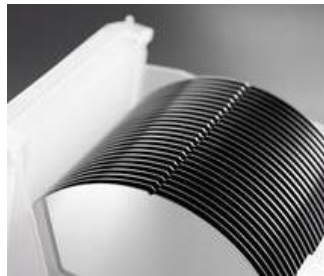
Gallium
Arsenic
Chemicals, Boron
oxide, Crucibles
etc.

GaAs Wafer

Al/Ga/As/
In/Ga/As; ...
Epitaxy

RF-Electronic:
HBT, HEMT, BiFET
Optoelectronic:
LED, Laser,
Solar cells

Mobile phones
Wireless Com.
Fiber Com.
Automotive
Displays



GaAs Wafer Products

LEC
Liquid Encapsulated Czochralski



VGf
Vertical Gradient Freeze



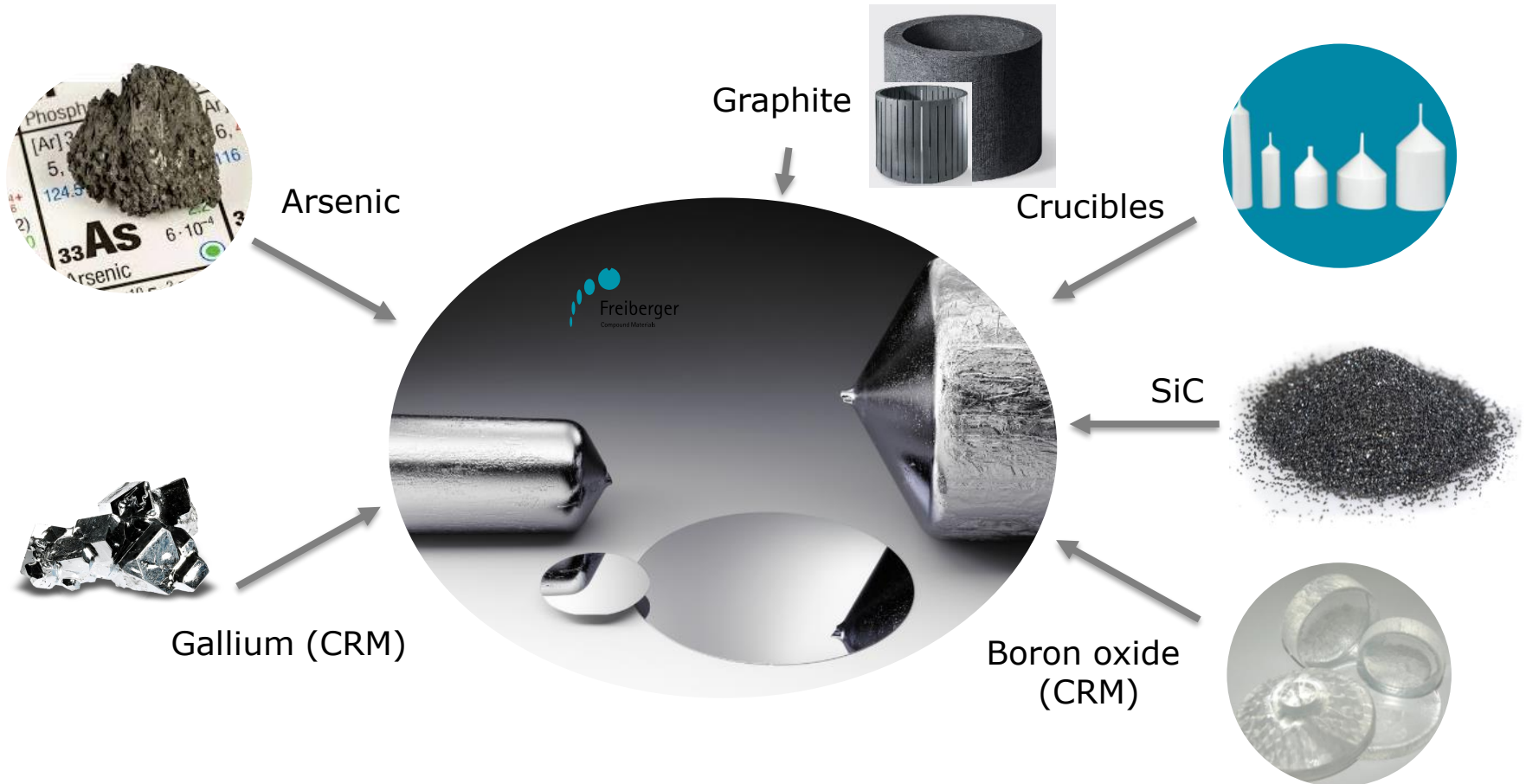
doping	Semi-insulating		Semi-conducting		Semi-insulating		Semi-conducting		
	C		Te		C		Si	Zn	
wafer size	3" 4" 6"		3" 4"		3" 4" 6" 8"		3" 4" 6" 8"		4" 6"

FCM Core Products
 Rising Stars

Critical Supply of GaAs-Production

Raw Materials

Crucial Auxiliary Materials



Raw Material Supply – Resilience

Raw materials



GaAs crystals

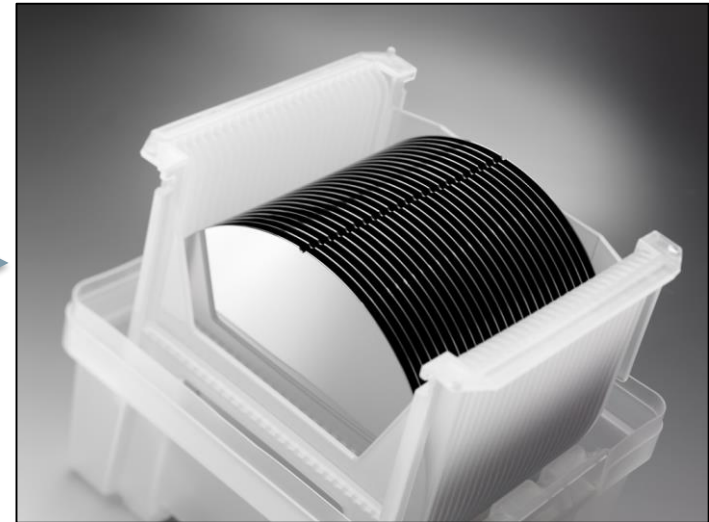


GaAs Substrates

Sawing

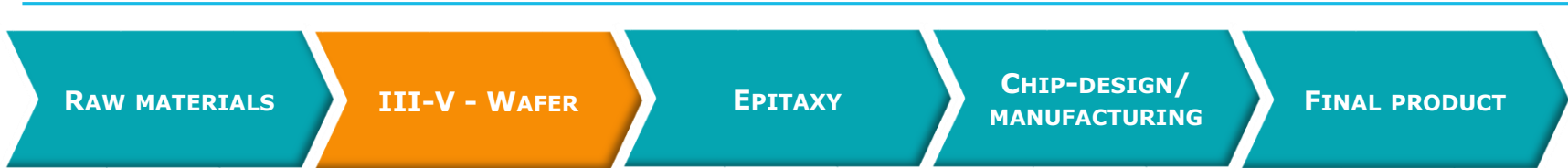
Polishing

Cleaning



German activity has been closed 2015
Gallium supply from China only -> 100% dependent

GaAs Supply Chain – RF Wireless Communication (global)



Gallium

珠海方源
ZHUHAI FANGYUAN

CHALCO

VITAL

Arsenic

FURUKAWA CO.LTD.

VITAL

PPM | Pure Metals
PPM Reinstmetalle
Osterwieck GmbH

IQE

SKYWORKS

SAMSUNG

AIRBUS

QORVO
all around you

AVAGO
TECHNOLOGIES

APPLE

NOKIA

WIN SEMICONDUCTORS

WIN SEMICONDUCTORS

HUAWEI

SUMITOMO

HISILICON

HISILICON

SONY

CISCO

PAM-XIAMEN
Xiamen Powerway Advanced Material Co., Ltd.

三安光电
Sanan Optoelectronics

MI

ERICSSON

AXIOM

INTELLI EPI

UMS
United Monolithic Semiconductors

LG
Life's Good

AWSC
Advanced Wireless Semiconductor Technology

SUMITOMO CHEMICAL

lenovo

Head quarters only

GaAs Supply chain – RF Wireless Communication (Europe)



Gallium

Arsenic

PPM | Pure Metals
PPM Reinstmetalle
Osterwieck GmbH

Freiberger
Compound Materials

United Monolithic
Semiconductors

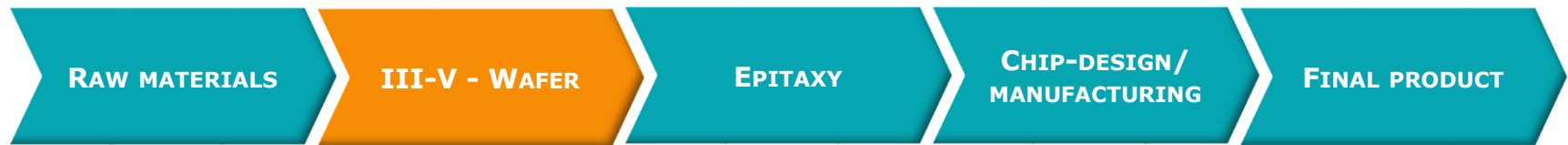
AIRBUS

NOKIA

ERICSSON

Head quarters only

GaAs Supply Chain – Opto-Electronic (global)



Gallium

珠海方源
ZHUHAI FANGYUAN

CHALCO

金安铝业
VITAL

Arsenic

FURUKAWA CO.,LTD.

VITAL

PPM | Pure Metals
PPM Reinstmetalle
Osterwieck GmbH

Freiberger
Compound Materials

SUMITOMO



VITAL



amun OSRAM
Sensing is life. Opto Semiconductors

NICHIA LUMILEDS

II-VI

VERTIGITE

唐晶量子
WaferChina

IQE

VPEC

WIN SEMICONDUCTORS

SUMITOMO CHEMICAL

AZURSPACE
SOLAR POWER GMBH

amun OSRAM
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LUMENTUM

WIN SEMICONDUCTORS

VISHAY

TRUMPF

JENOPTIK

AZURSPACE
SOLAR POWER GMBH

Apple

SAMSUNG

MI

HUAWEI

ERICSSON

DELL

hp

SONY

lenovo

LG
Life's Good

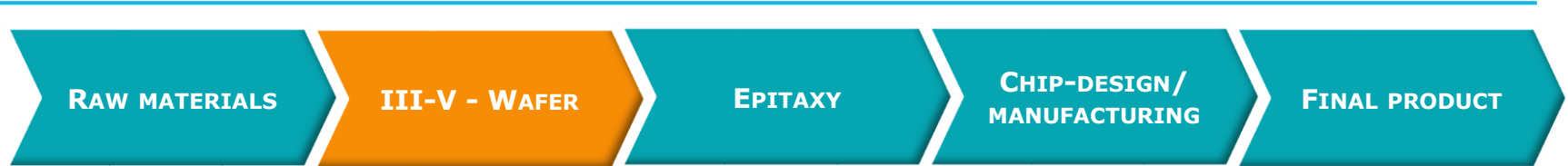
Mercedes

B M W

Audi

Head quarters only

GaAs Supply Chain – Opto-Electronic (Europe)



Gallium

Arsenic

PPM | Pure Metals
PPM Reinstmetalle
Osterwieck GmbH

Freiberger
Compound Materials

amun OSRAM
Sensing is life. Opto Semiconductors

amun OSRAM
Sensing is life. Opto Semiconductors

ERICSSON

AZURSPACE
SOLAR POWER GMBH

VISHAY

TRUMPF

JENOPTIK

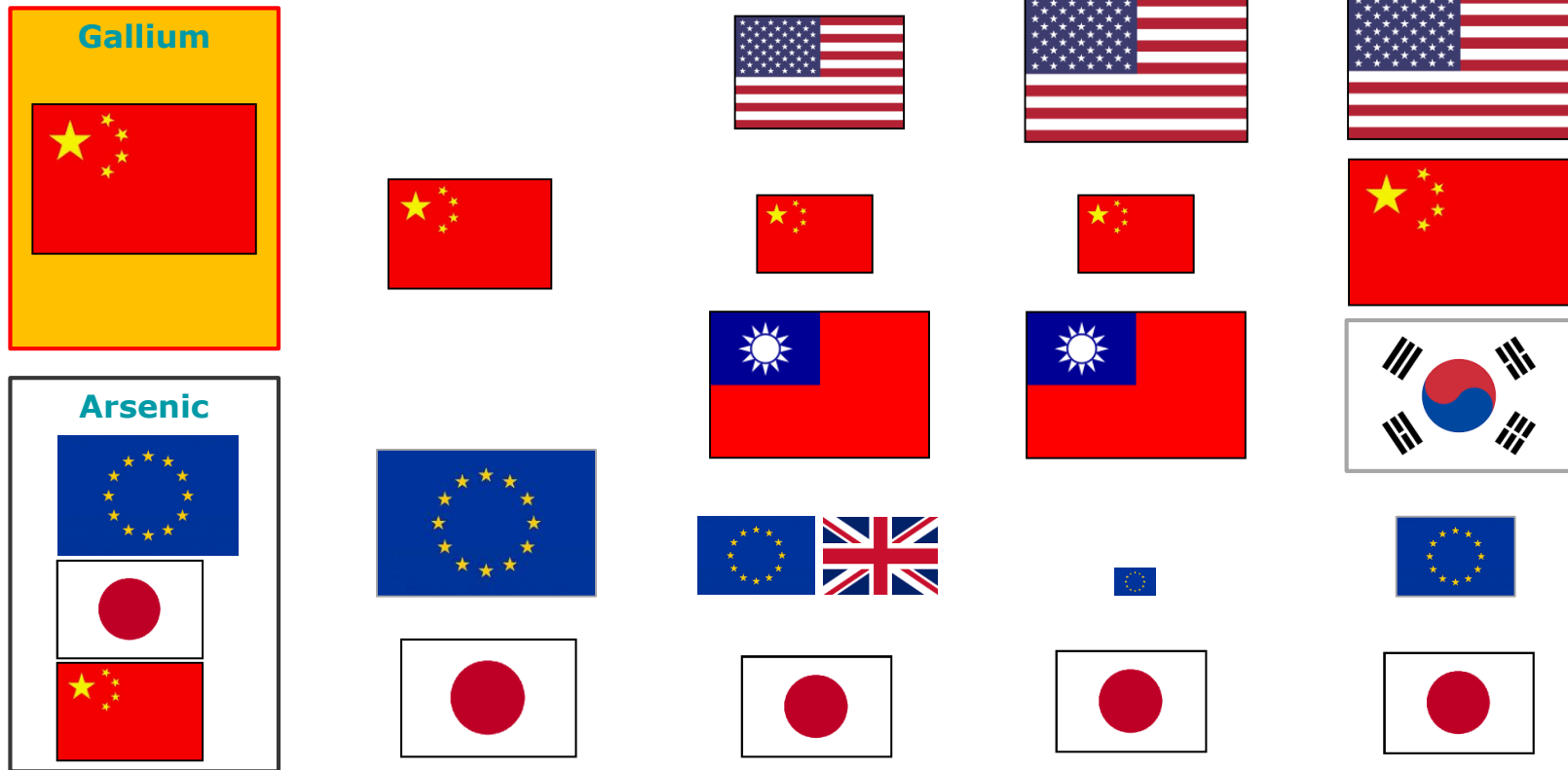
AZURSPACE
SOLAR POWER GMBH

B M W

Audi

Head quarters only

GaAs Supply Chain for Wireless Communication (global regions)

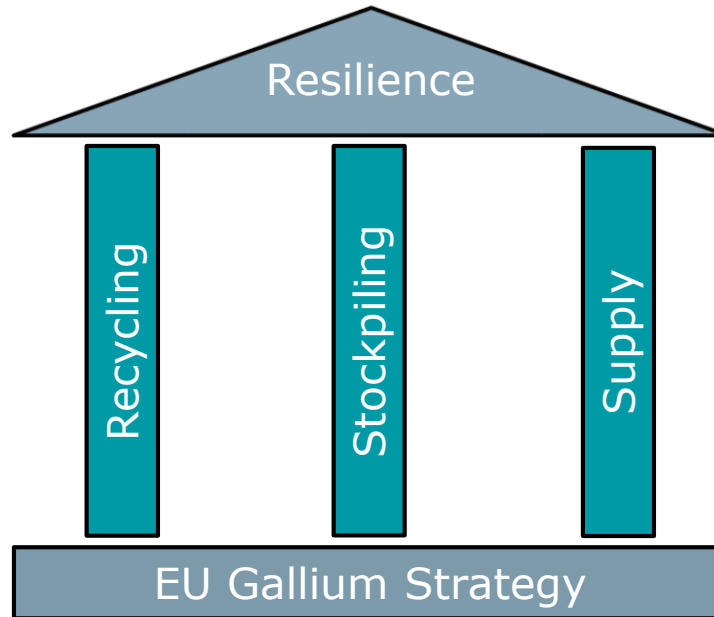


*) Size of flags corresponds to market share

CRM ACT – Gallium – 3 Pillar Strategy

EU Recycling:

- Increase/stabilize efficiency and cost
 - Decreases dependency on virgin Gallium
 - Reduces ecological footprint
- CAPEX: 15 m€
 - R&D funding: 5 m€



EU Supply:

- Stabilize resilient supply long term
 - Increase EU autonomy
 - Highly efficient technology reduces the ecological footprint
- CAPEX: 15 m€
 - R&D funding: 10 m€

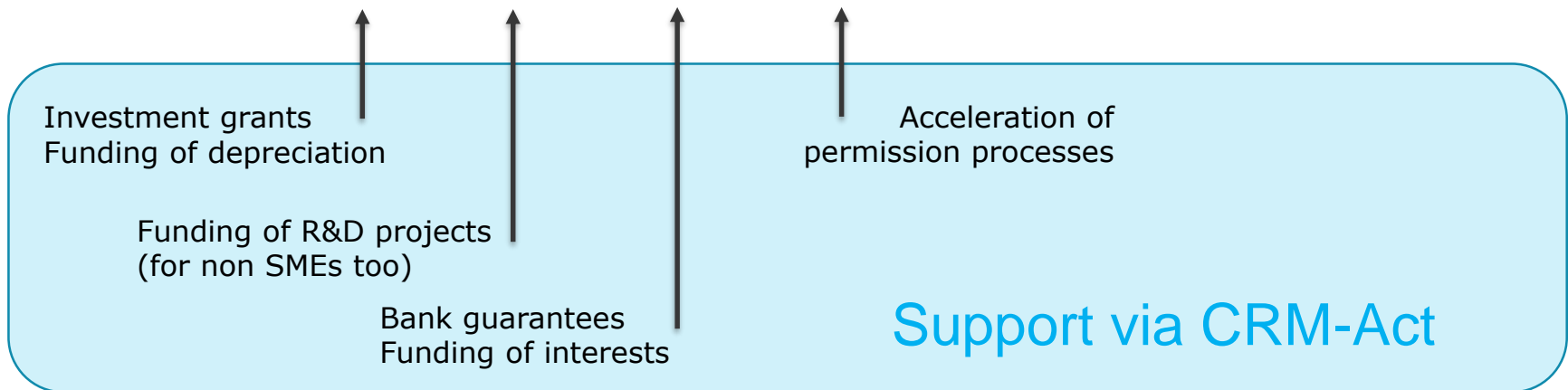
EU Stockpiling: (100 t, 2-3 year)

- Stabilize market
 - Reduces price speculation
 - Bridge short term shortages in case of international crisis
- Bank guarantee for loan of 30 m€
 - Interest rates

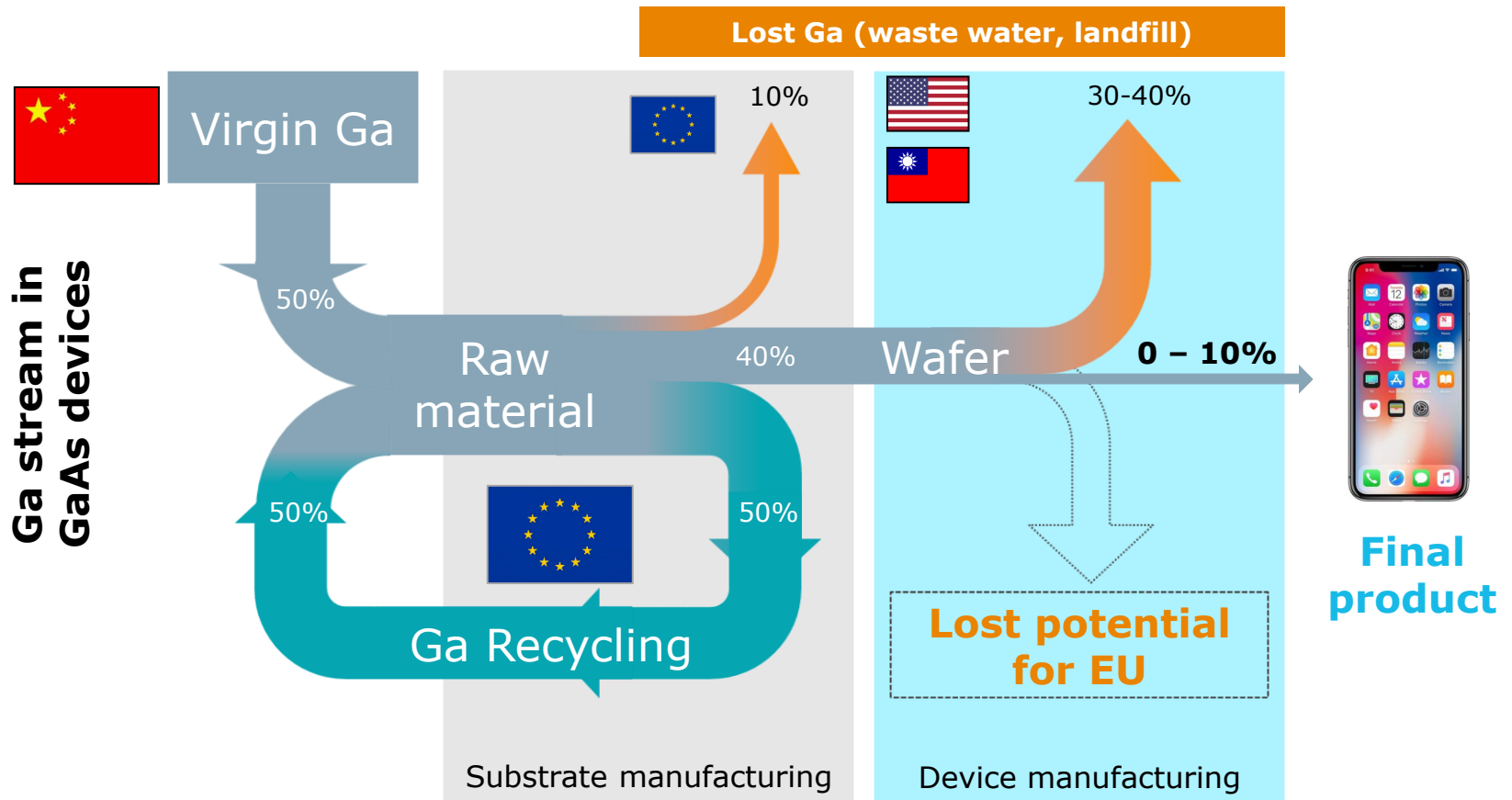
CRM Act –Gallium – 3 Pillar Strategy Proposal

Financial figures and timetable

	Capex	R&D Funding	Bank guarantees	2023	2024	2025	2026	2027
EU Recycling	15 m€	5 m€		Build-up facilities	R&D / Pilot	Ramp-up		
EU Stockpiling (100t)			30 m€ interest	Set-up	Filling stock	Filling stock	Filling stock	
EU Supply	15 m€	10 m€		Permissions	Build-up facilities	R&D	R&D / Pilot	Ramp-up
Total	30 m€	15 m€	30 m€					



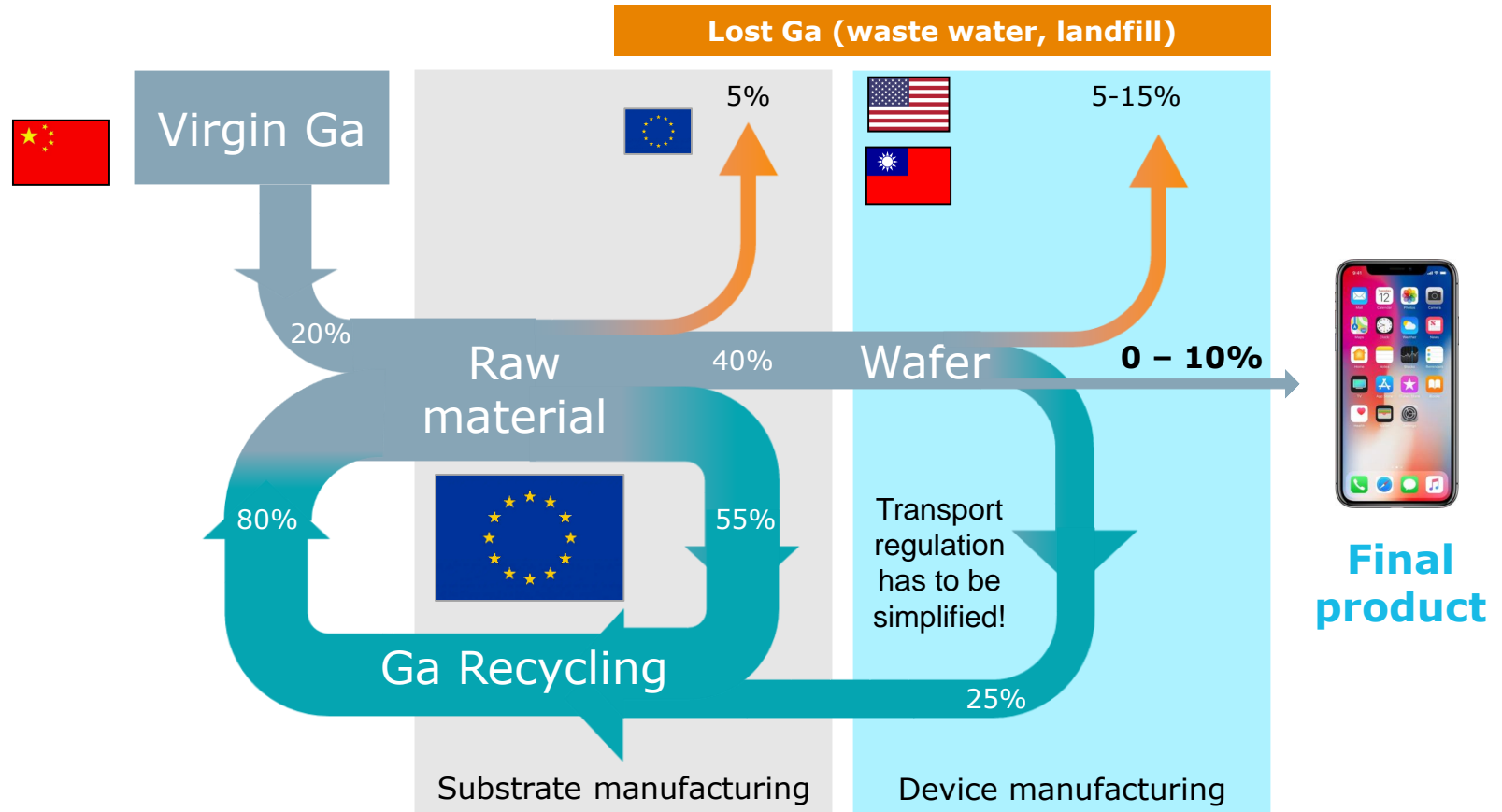
Gallium Recycling – 50% (current status)



Targets of Ga Recycling:

- Saving virgin raw materials – Increase EU resilience
- Stabilizing costs & protecting the supply chain against market volatility
- EU to promote recovery/recycling of gallium

Gallium Recycling – 50% ->80% (2026)

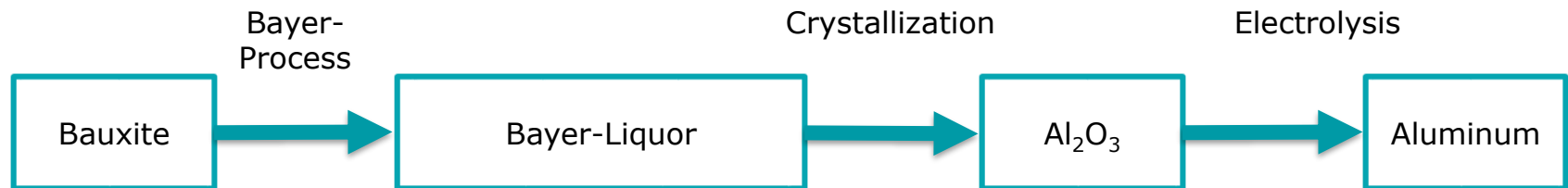


Transport regulations:

- GaAs back grinding sludge has to be declared as hazardous waste
- Transport/shipping permission, Export/Import notification are very difficult
- Definition as recyclable raw material would be helpful

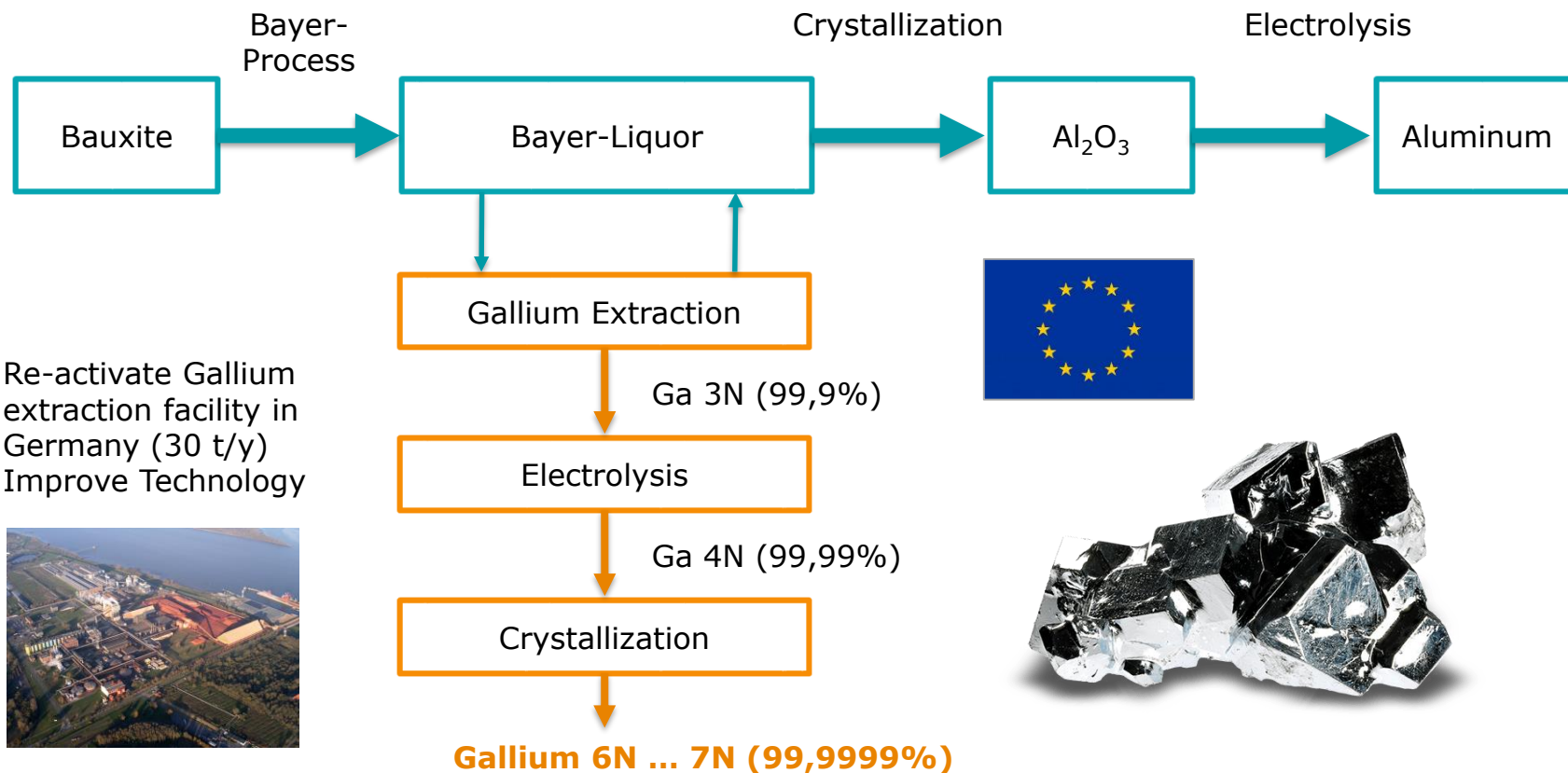
Virgin Gallium production

Gallium is a by-product from Aluminum value chain.



Virgin Gallium production

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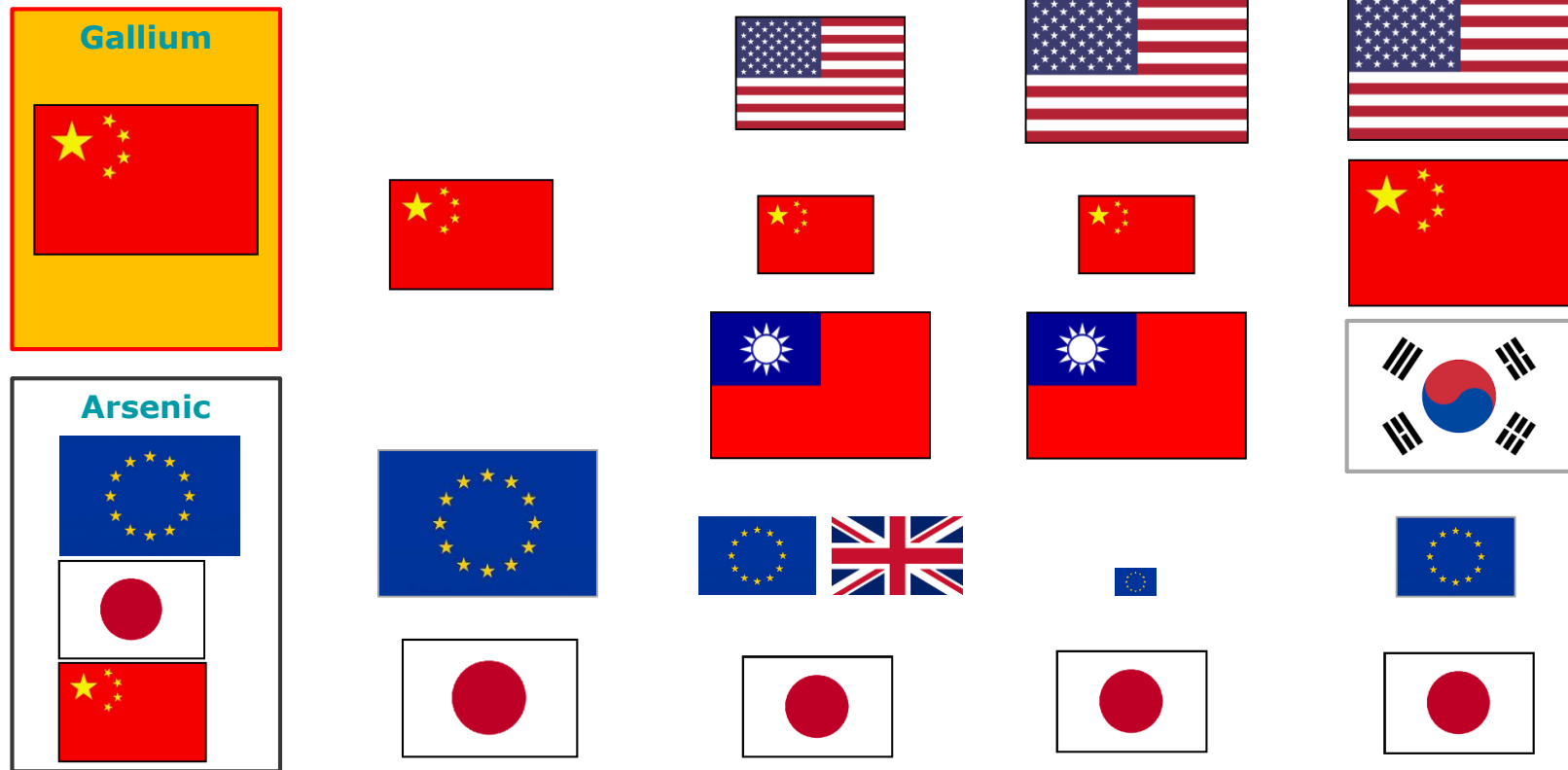
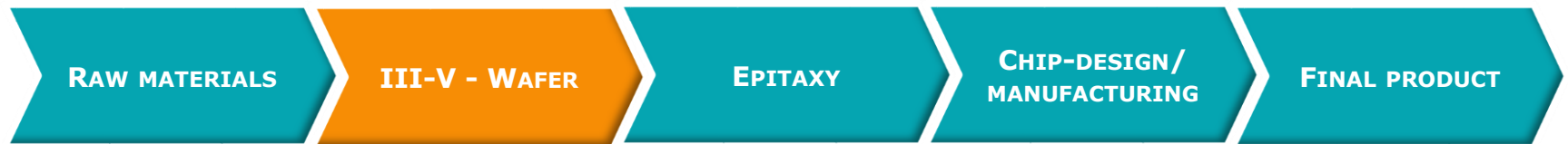


- Re-activate Gallium extraction facility in Germany (30 t/y)
- Improve Technology



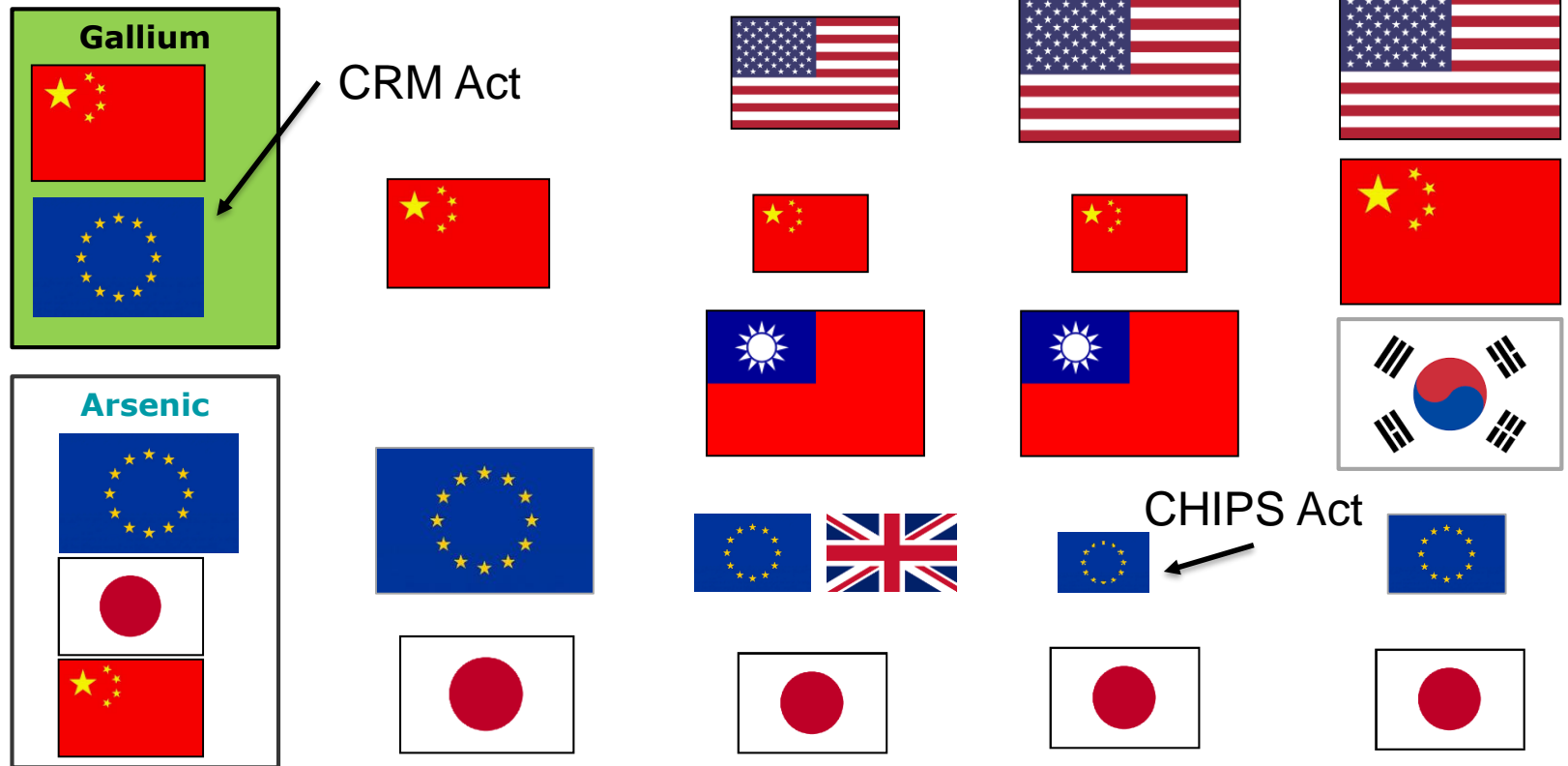
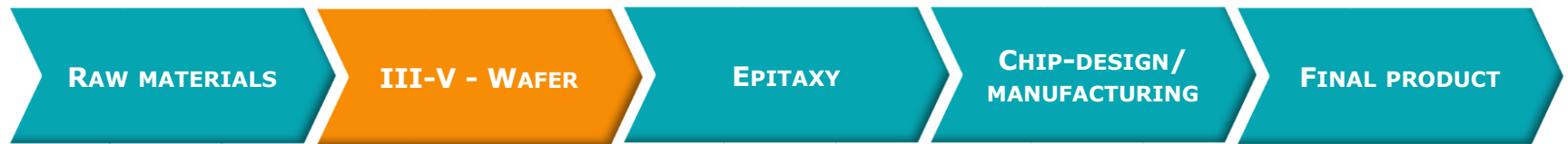
N(9) - means purity level

GaAs global Supply Chain for Wireless Communication (Current Status)



*) Size of flags corresponds to market share

GaAs global Supply Chain for Wireless Communication (Target 2027)



*) Size of flags corresponds to market share

Summary – take away

- Gallium is a strategic raw material enabling many essential product applications, crucial in the further Digitalization, Clean Energy and Green Deal goals
- Virgin Gallium Supply is 100% dependent from China today, even if the supply volume is small (below 50 t per year)
- The 3 pillar strategy:
 1. EU Recycling (50% -> 80%)
 2. EU Stockpiling (100 t)
 3. EU Supply (30 t/year)

has the potential to sustain EU's autonomy for Ga supply by 2027

- The needed financial effort to support the 3 pillar strategy can be estimated to 50 m€ in total (2023-2027)



EU Gallium supply should be secured by the EU CRM-Act through inclusion in the new strategic list of raw materials.

Questions?

THANK YOU

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