Emberion Oy – Experiences in European Networks and Funding

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Emberion Oy

High-performance infrared imaging products for a broad wavelength range from visible light to LWIR

- First products for vis-SWIR range imaging for spectrometry, night and machine vision
- Broadband imagers offer unforeseen opportunities for hyperspectral imaging

Spin-off from Nokia, based on Nokia's long-term research in the EU Graphene Flagship

- Co-founded in 2016 by employees and two VC Funds managed by a Finnish VC Verso Capital Oy

A team of 26 top experts representing a unique combination of skills and experience:

- Nanomaterials and sensor development in Cambridge, UK
- Electronics and system design in Espoo, Finland

Leadership in top-notch industrial R&D programs

- Spearhead project leader in EU Graphene Flagship project and working with the Graphene Foundry project
- Established business relationships with CMOS foundries
- Working with AMO (University of Aachen), Graphenea, Cambridge University and VTT

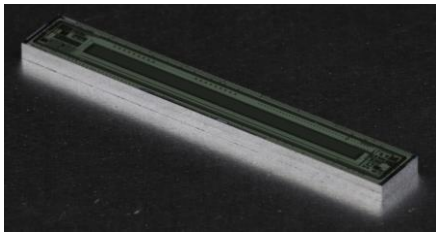
Unique Product; Unique Technologies

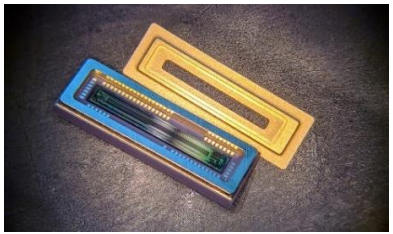
Night & machine vision cameras:

- VGA resolution broad wavelength range cameras for machine vision applications
- Based on Emberion's IR image sensors

Infrared image sensors:

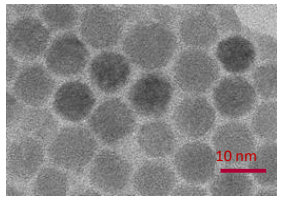
- Single-chip imaging sensors for 400-2100 nm wavelengths





Nanotechnologies for imaging:

1) Low cost manufacturing of new nanocrystalline photon absorber layers that enable broad wavelength range



2) Use of 2D graphene enables simplification of fabrication processes and significantly improved sensor performance

3) High performance readout electronics that enables high frame rate necessary for machine vision

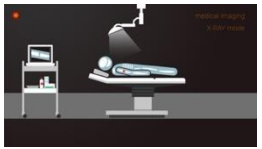
Emberion's Mission

Emberion's short-wave and mid-wave infrared (SWIR, MWIR) cameras provide a solution for various applications driven by machine vision and artificial intelligence:

1) Our significantly wider spectral information in **industrial machine vision systems** enables broader use, new applications. Affordable SWIR & MWIR cameras enable plastic waste sorting in a big way – incl. black plastics.

2) Our low noise SWIR & MWIR performance enable excellent situational awareness in **demanding surveillance, defense, port & border security**. Extreme long-range visibility through fog, smoke, rain, snow & darkness.

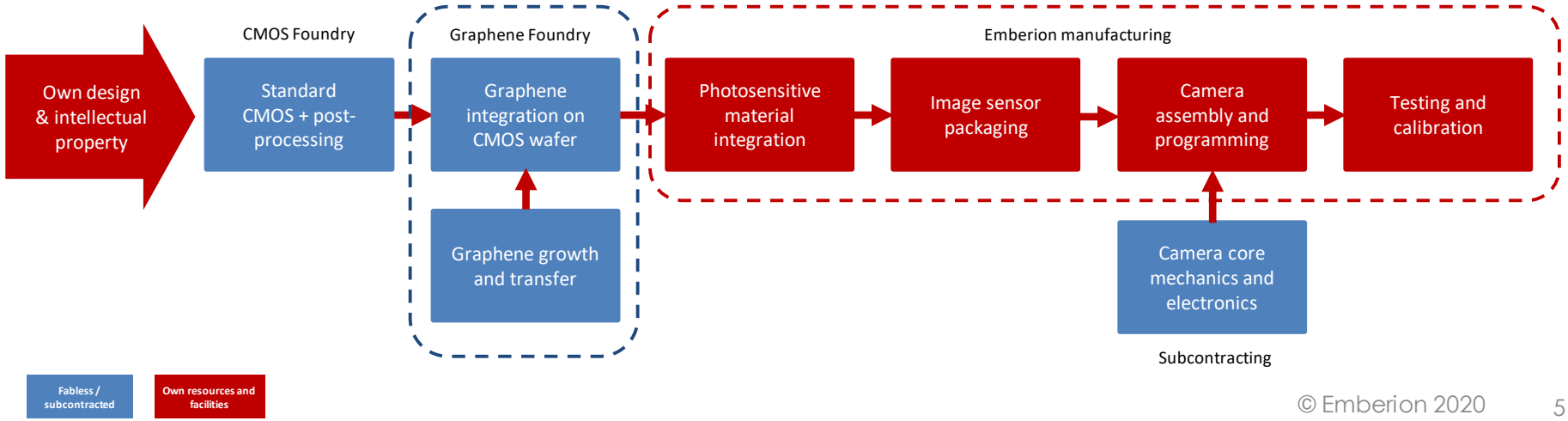
3) Our low manufacturing cost enables eventually integration of SWIR&MWIR cameras into **level 4 & 5 autonomous vehicles**. Vision through fog and rain together with situational awareness are needed for safety and comfort.



4) Our miniature, high performance SWIR image sensors enable accurate and fast **medical imaging and diagnostics**. SWIR imaging can be used for eye inspection, endoscopy, skin cancer and caries diagnostics.

Semi-Fabless Manufacturing

- **Semi-fabless operation**: We utilize subcontractors for various established manufacturing steps but keep all the **performance critical steps in house**
- Emberion manages the whole manufacturing process through its captive know-how and IPR and concentrates own resources on the new value adding processes
- Overall system design by Emberion



EU Funding

Nicholas Wallace, "*European Union gets in the venture capital game, Flush with cash, new EU innovation agency buys shares in disruptive technology startups*", Science 368, pp. 120-121, 10 April 2020.

- "A lack of venture capital (VC) has slowed tech growth in Europe … when it comes to the growth stage, scaling companies, there might not be that many investors that are risk takers"
- "EIC will help companies that need more time and money to get market ready … developing disruptive technologies"
- EIC is targeting to "investment impact" via co-investments (equity) in new technology companies

From Research to Innovation Funding

Emberion's experiences in

1) EU FET Graphene Flagship project, 2016-2023
   - Research during 2016-2020; flexible x-ray detectors
   - Spearhead project leader 2020 - ; infrared image sensors

2) Fast Track to Innovation (FTI) project, G-Imager, 2018-2020

EU FET Flagships

Flagships are visionary, science-driven, large-scale research initiatives ***addressing grand Scientific and Technological (S&T) challenges****. They are* ***long-term initiatives*** *bringing together excellent research teams across various disciplines, sharing a unifying goal and an ambitious research roadmap on how to achieve it.*

- Emberion is a full member of **EU FET Graphene Flagship project** since 2016; and the Emberion team were among the founders as Nokia employees.
- Since April 2020, Emberion is a leader of one of the Spearhead project to develop a camera that detect light from visible to long-wave IR with a single image sensor together with Graphenea SA, University of Cambridge and VTT.

- Question: How can an Early Phase Company succeed in long-term Research Projects? And what is the benefit?

GRAPHENE FLAGSHIP

EU FET Flagship since 2013. Europe's biggest ever research initiative; €1 billion over 10 years.

Driven by applications in, e.g., composite materials, energy technologies, electronics & photonics, and biomedical materials and sensors.

Academic and industrial researchers to take graphene from academic laboratories into European society.

Industry driven spearhead projects to commercialise new material solutions.

Experimental pilot line for 2D materials (2D-EPL), hosted by AMO, iHP, IMEC and VTT.

146 academic and industrial research groups in 21 countries and 82 associated members.
12 spin-off companies.

Graphene Flagship for SMEs

- Community to learn and understand new options
  - Technology development beyond the current scope
  - Research at lower risk and investment
  - Technology transfer opportunities from the Universities

- Risk sharing with other companies
  - Working together on selected and shared bottlenecks of productisation
  - Investments on development of critical fabrication processes
  - Building the value chains:
    from research to manufacturing and from materials to end products

SMEs for Graphene Flagship

- Acid test for the new technologies:
  - Direct connection to market needs and application requirements
  - Building the value proposition for different vertical applications
  - Testing the manufacturability and robustness of the new technologies
- Products
  - Much beyond demonstrators – bringing real customer feedback
  - Defining technology development priorities – speeding up the introduction of the new technology
  - TRLs are defined for space programs – not for SME product development

Fast Track to Innovation

Fast Track to Innovation (FTI) is a fully-bottom-up innovation support programme promoting close-to-the-market innovation activities open to ***industry-driven consortia*** *that can be composed of all types of participants. It can help partners to co-create and test breakthrough products, services or business processes that have the potential to revolutionise existing or create entirely new markets, under the helm of the Enhanced European Innovation Council (EIC) pilot.*

- Emberion is participating in a FTI project G-Imager to create a rapid prototyping "foundry service" (Graphenea SA, San Sebastian, Spain and AMO GmbH, Aachen, Germany), a new Graphene Imager product (Emberion) and to scale up the production capacity (all the partners). Started in September 2018.

- Question: How is it possible to use FTI funding to create a supply chain?

G-Imager FTI Project

Emberion
Espoo, Finland
Cambridge, UK

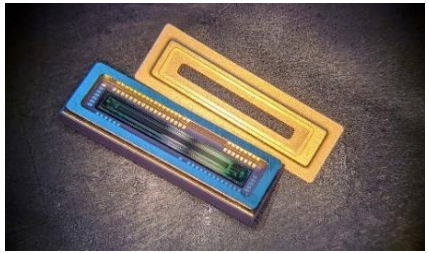
Deposition of the photosensitive nanocrystalline layers, imager sensor encapsulation and packaging.

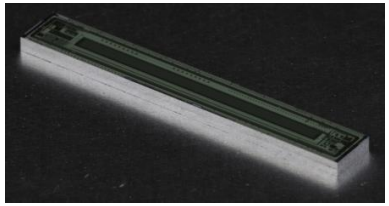
AMO GmbH
Aachen,
Germany

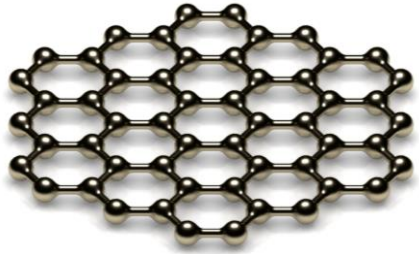
Graphene lithography and fabrication of graphene FET devices on 200 mm CMOS wafers.

Graphenea SA
San Sebastian,
Spain

Growth and transfer of graphene in 200 mm wafer scale in production volumes.







Building Industry-Driven Consortia

- Complementary assets and capabilities:
  - Clear roles of the business partners – building a supply chain
  - Scalable business model – for every partner
  - Clear investment focus on complementary areas
- Ambitious, innovative and realistic targets:
  - Concrete end target for the project that makes difference
  - Measurable business targets – significant business opportunities
  - Novelty – leading edge technology development

Some Concluding Remarks

Working in EU projects set requirements on partners:

- Resourcing the project – work and other assets
- Booking keeping of cost and work hours (work hour reporting)
- Periodic reporting of results to the project coordinator

Coordinator role can be more demanding:

- Project management
- Collecting and compiling the financial and technical reports
- Organising the project meetings and communication

All our EU contacts have been very helpful; amendments have been handled in flexible and timely manner.

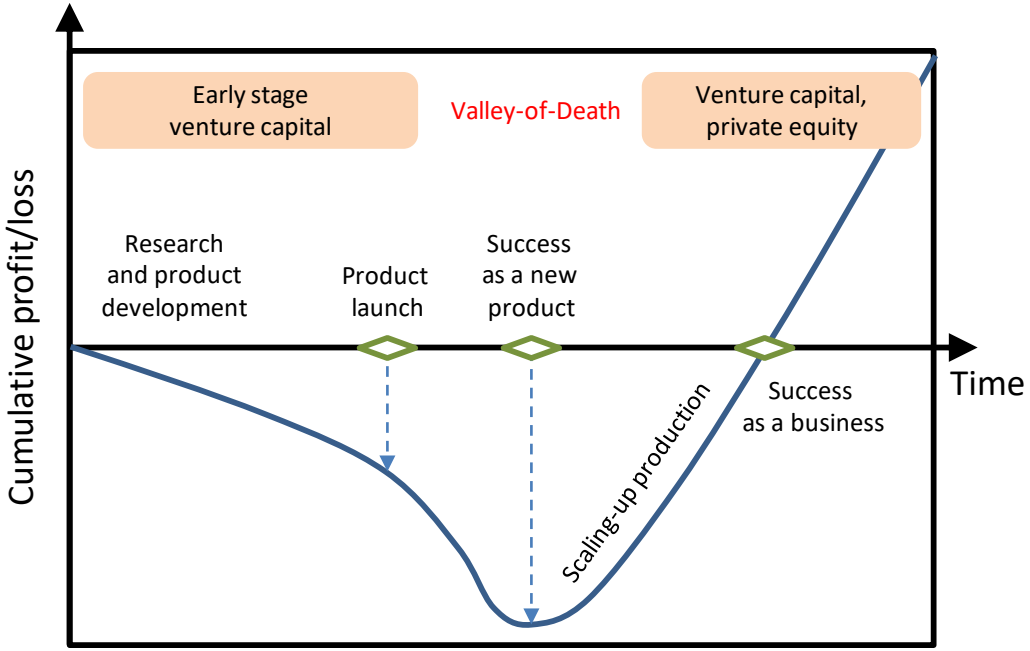
Through the Valley of Death

All the early phase companies face to the challenge to bridge over the valley of death:

- Early phase investments will not carry
- Scaling up the customer interface and production require significant investments

Beyond venture capital funding, EU funding instruments can be interesting for early phase companies:

- Research projects / consortia
- EIC Pathfinder, Accelerator & FTI: grants, equity and mixed funding



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