Alminica AB

Sweden

Transfer of knowledge in **Advanced Materials**

Tokenization of CS-PVT

Innovations from EU projects
SiComb (EU FET Open)
rePowerSiC (EIC Pathfinder)

One thing led to another

ALMINICA

How it started

In 2008, Dr. Mikael Syväjärvi and Prof Satoshi Kamiyama, Meijo University, Japan came in contact about new research avenue related to fluorescent silicon carbide. That is the material for a new type of white LED. Prof Kamiyama is expert in nitrides and LED, and Dr Syväjärvi expert in growth of silicon carbide.

Dr. Syväjärvi initiated EU collaboration with Prof Dr. Peter Wellmann (Friedrich-Alexander-Universität Erlangen-Nürnberg - FAU), Dr. Haiyan Ou (Technical University of Denmark - DTU) and Dr. Mats Bladh (Linköping University). They got project NORLED (Norther Light Emitting Diode Initiative 2010-2014) that was funded via Nordic Energy with Dr. Syväjärvi as coordinator. It was one of four accepted projects (from total 51 applications). The consortium had 11 partners with funding 700 kEUR.

Since then Syväjärvi, Wellmann and Ou have collaborated in various projects and new avenues related to photonics using silicon carbide. That led to projects SiComb and rePowerSiC.

About

Alminica AB is founded by Dr. Mikael Syväjärvi

He has worked in SiC since 1994 by master thesis in electrochemical etching of silicon and SiC. He has more than 200 publications in SiC. He started with SiC crystal growth in 1995 and explored the physical vapor transport (PVT) growth, liquid phase epitaxy (LPE), and sublimation epitaxy.

He was implementation responsible for LPE development for the worlds first SiC microgravity growth in 1997 on the sounding rocket MASER7. Since 2005 he is active in graphene on SiC growth and co-founder of Graphensic AB (2011) that is the first SME in EU in epitaxial graphene on silicon carbide. He is main inventor of Fast Sublimation Growth Process (FSGP) and responsible for the technology transfer of FSGP to El Seed Corporation, Ltd (Jp). The process was further developed to have basal plane defect free SiC in KISAB company. He founded Alminica AB in 2016 for innovation services for research to business, impact from reseach and training young generation researchers. He has experience from broader contexts for research to market, such as avenues in European research and innovation strategy for smart specialisation for regional economic growth using the entrepreneurial discovery process, and strategic national innovation programme SIO Graphene where he was in board (2014-2018). He is active in global partnerships for promoting impact from research, educating next generation research leaders, and establishing supply chains and value chains using sustainable manufacturing. He suppors several start-ups in deeptech (mentor, adviser, etc). For transfer of knowledge he has create the portals Research to Business and International Conference (Series) on SiC (IW-SiC).

Links

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www.alminica.se | mikael@alminica.se
www.iwsic.tech
www.researchtobusiness.tech
www.icmresearchinstitute.se

Fluorescent silicon carbide

The silicon carbide acts as a phosphor. It is excited by near UV LEDs. The white light comes from two layers: one warm white and one blue. Below inages show light emission from warm white layer and from a white LED demonstrated by Prof Kamiyama.

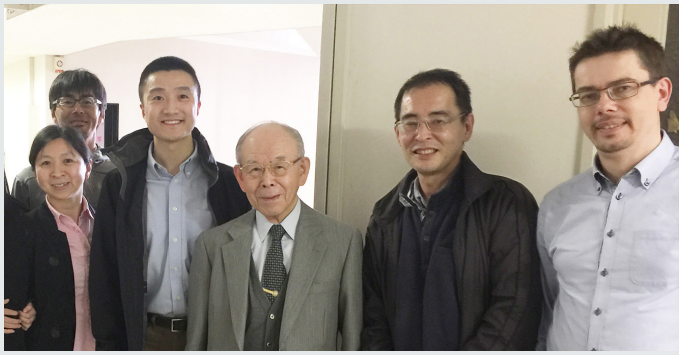
The light emission does not use rare earth metals. The silicon carbide acts as a phosphor but does not degrade since it is based on a semiconductor. It offers novel research as new technology. It also resulted in several joint projects between Sweden, Denmark, Germany and Japan:

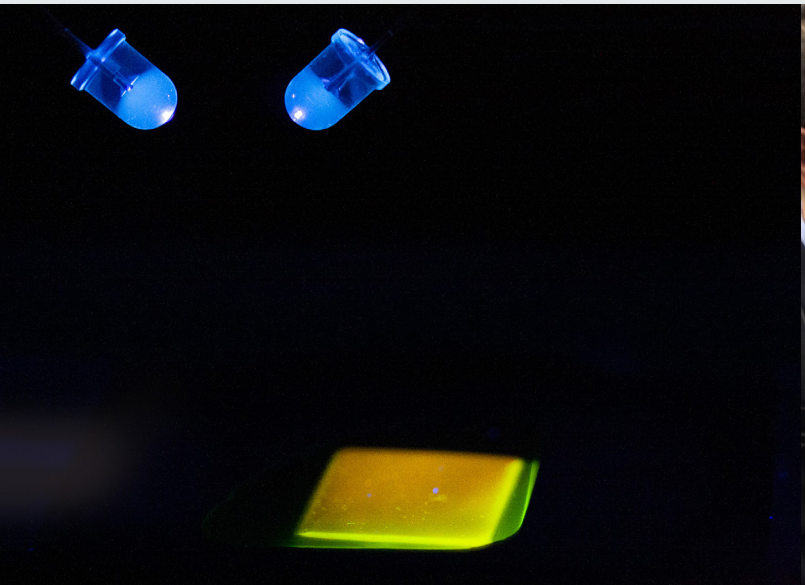
- New-Energy and Industrial Technology Development Organization, Japan, “Development of white LED by substrate technology” 6 MSEK 2010-2011. Coordinator Satoshi Kamiyama, El Seed Corp.

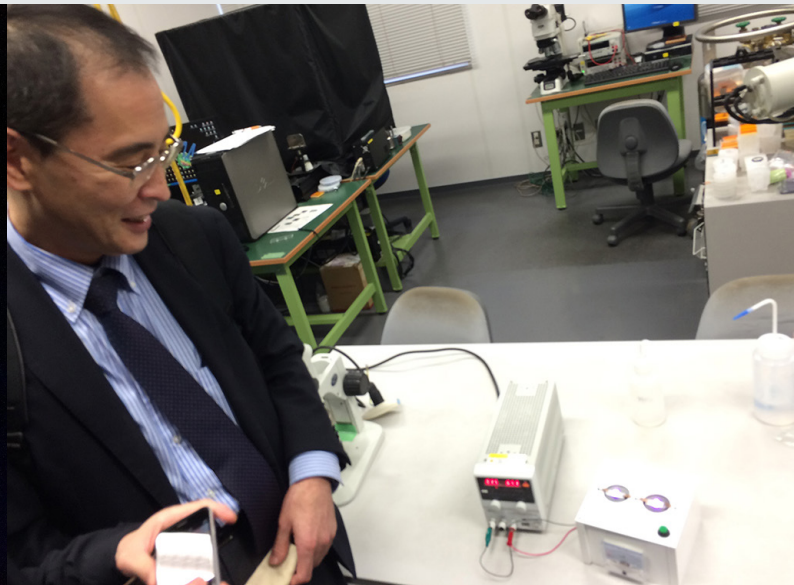
- Japan Society for the Promotion of Science, Meijo University (Japan), Coordinator Satoshi Kamiyama, Meijo University.

Innovation Fund Denmark, “A new type of white light-emitting diode using fluorescent silicon carbide (LEDSiC)“ 2015-2018, Coordinator Haiyan Ou.

Prof. Kamiyama is part of team with Prof Isamu Akasaki
(Nobel Prize Physics 2014)







SiComb

Haiyan Ou proposed project on frequency comb in silcon carbide. The collaboration Syväjärvi, Wellmann (FAU) and Ou (DTU) continued.

SiComb: ” CMOS compatible and ultra broadband on-chip SiC frequency comb”: Oct 1, 2020 - March 31, 2024.

EU FET Open (EXCELLENT SCIENCE - Future and Emerging Technologies - FET)
Total cost € 2 914 295,00

FAU developed material, DTU studied at device level and Alminica role was Transfer of Knowledge, Risk and Innovation Management, and Exploitation.

Dr. Syväjärvi gained insight that the researchers mainly disseminate but are less active to create transfer of knowledge. Dissemination is mainly at conferences, but presenting at conference is not often (maybe once per year). In silicon carbide there is one main conference annually. At the same time there was the pandemic. Researchers and others became familiar with online tools. Alminica initiated and developed an online platform for exchange and more opportunities for transfer of knowledge: **IW-SiC** (www.iwsic.tech) which was one of five innovations in SiComb Innovation Radar.

Online platform to facilitate Transfer of Knowledge and Innovation Capacity in Silicon Carbide

Market maturity: Tech Ready
Market creation potential: High
Project: SiComb
Innovation Topic: Excellent Science

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7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
17 PARTNERSHIPS FOR THE GOALS

Funded by the European Union

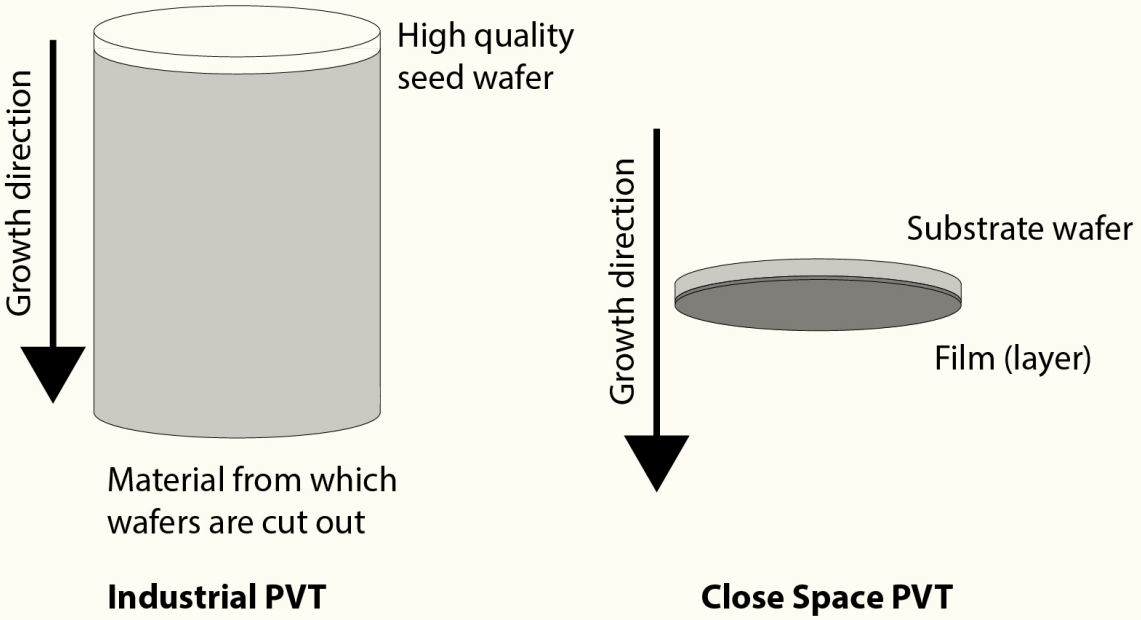
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 899679

SiComb post project

IW-SiC platform is highly active. Alminica continues to maintain it. It allows us to understand the transfer of knowledge to be able to exploit research outcomes.

The SiComb technical topic continues. Recently a MSCA Doctoral Network was accepted. The MSCA Doctoral Network SiCPIC (Silicon carbide photonic integrated circuit training network) that is led by Associate Professor Haiyan Ou will break new ground in photonics integrated circuit technology by unlocking the unique optical properties of silicon carbide leveraging the advancing of nanotechnology including thin film transfer and nanofabrication. The material is based on Silicon Carbide on Insulator (SiCOI) that refers to a structure where a layer of silicon carbide is deposited or grown on an insulating material like silicon dioxide or sapphire.

Alminica has strategic focus in close space physical vapor transport (CS-PVT) method. Dr. Syväjärvi is inventor of FSGP (Fast Sublimation Growth Process) that is based on silicon carbide layers on silicon carbide substrates. The PVT for wafers and CS-PVT are based on same physical process (sublimation).

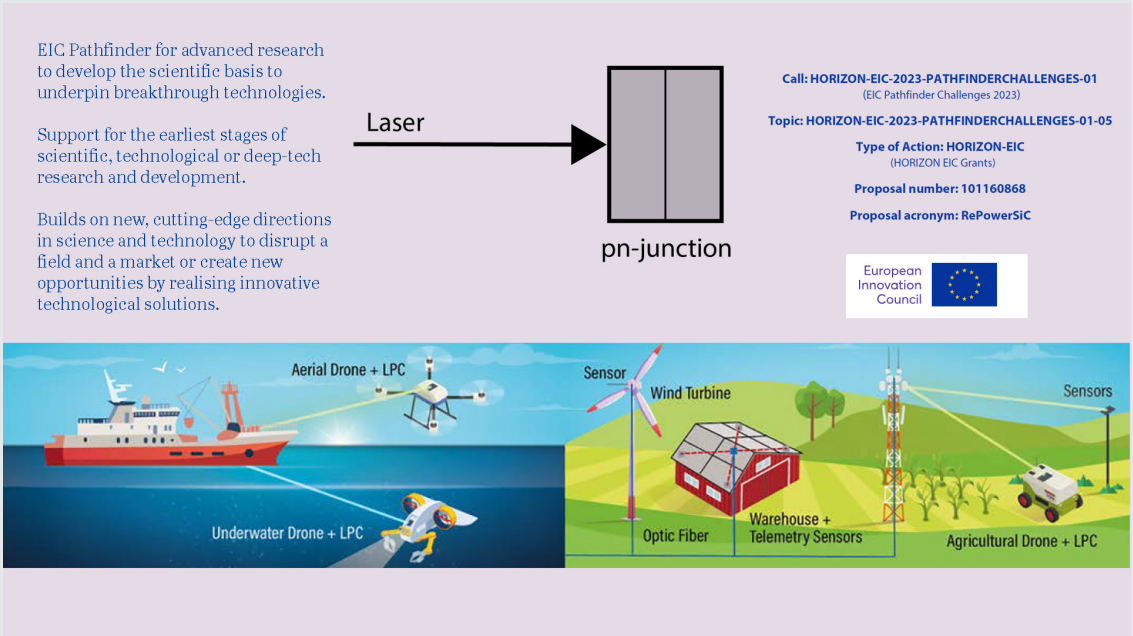


rePowerSiC

About five years ago Dr. Syväjärvi was contact by Prof Antonio García-Loureiro, Universidade de Santiago de Compostela, Spain. The team had done calculations for energy conversion in silicon carbide polytypes. One polytype was cubic silicon carbide. The conversion needs thick layers, and Dr. Syväjärvi has explored growth of cubic silicon carbide using CS-PVT. FAU and DTU were invited to discussions and a consortium was built. They applied for EU projects for high power laser conversion using silicon carbide. Finally a project was approved in EIC Pathfinder: rePowerSiC.

rePowerSiC: ” High efficient high-power laser beaming systems in space based on silicon carbide ”: Oct 1, 2024 - Sep 30, 2028.

EIC Pathfinder (HORIZON-EIC-2023-PATHFINDERCHALLENGES-01-05 - EIC Pathfinder Challenge: In-space solar energy harvesting for innovative space applications) Total cost € 4 025 771,25



rePowerSiC

Funded by the European Union

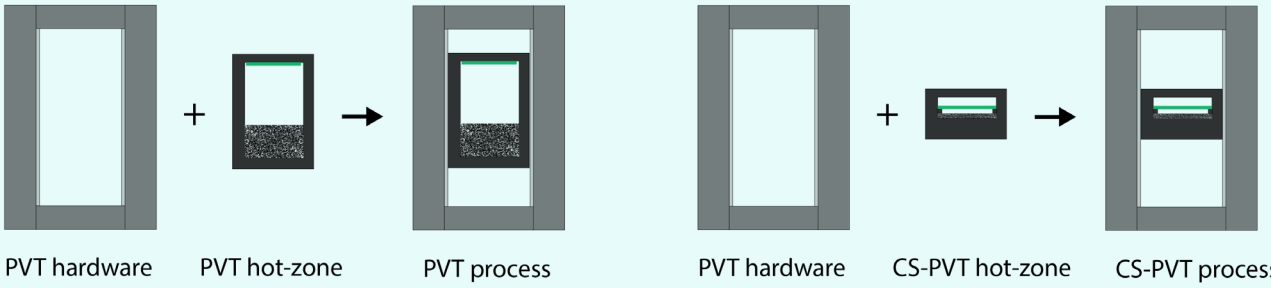
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101160868

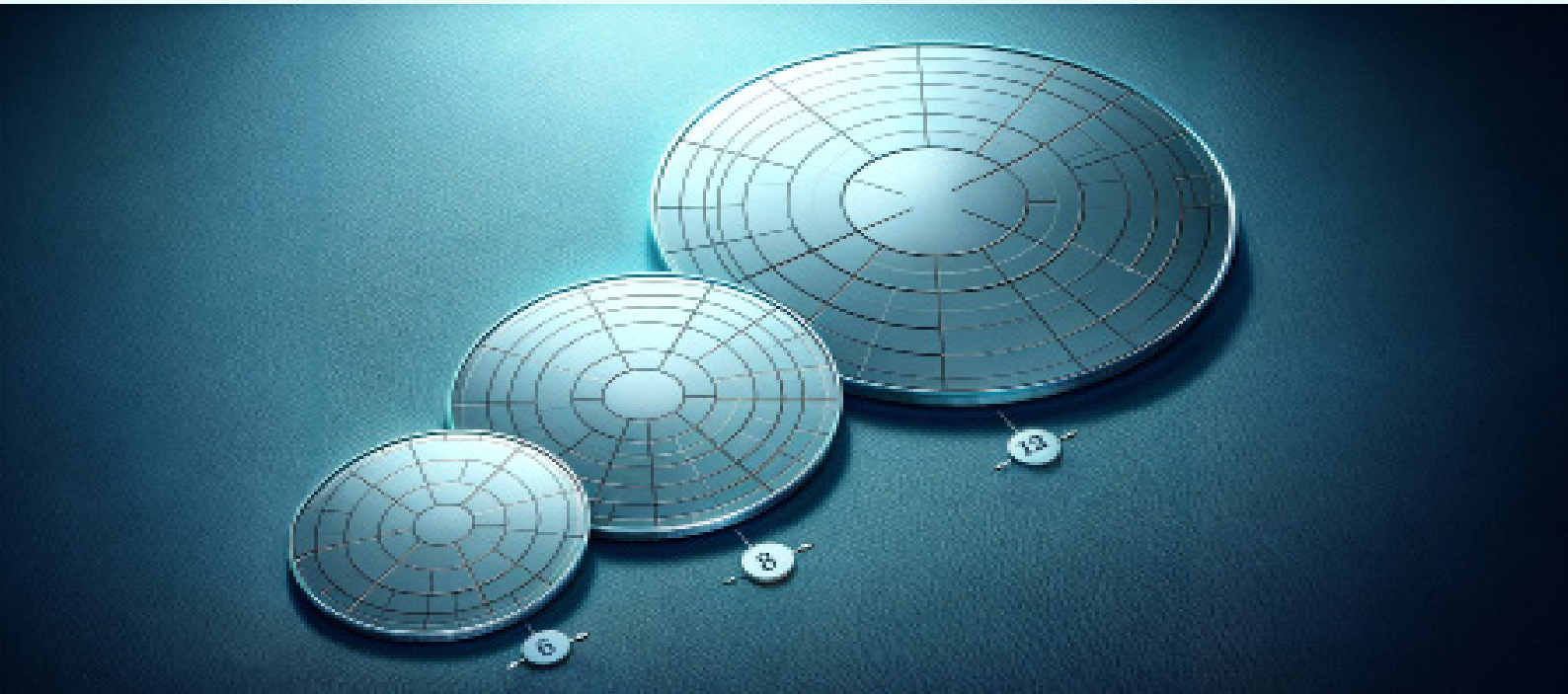
Innovation radar rePowerSiC

The CS-PVT is a green technology. It is based on layers grown on silicon carbide wafers. During recent year the silicon carbide wafer prices have dropped substantially since there is too many manufacturers. It is no longer possible to have profit in wafer manufacturing.

The PVT for wafers and CS-PVT use same equipment for heating. The only difference is hot-zone design. This means that when CS-PVT epiwafers for high power laser transmission is a commercial market, the PVT players will start with CS-PVT. The CS-PVT epiwafers will face same price war. The PVT players already have the equipment park.

Even with technical success, we will not be able to exploit CS-PVT





Innovation radar rePowerSiC

With Data Act, Data Spaces, Digital Product Passport, etc it is evident that data has to be shared. Alminica has spent two years to understand more about tokenization. That is the creation of value for business and sustainability from shared data and digitalization. Now we apply this to CS-PVT and our Innovation Radar contribution in rePowerSiC is:

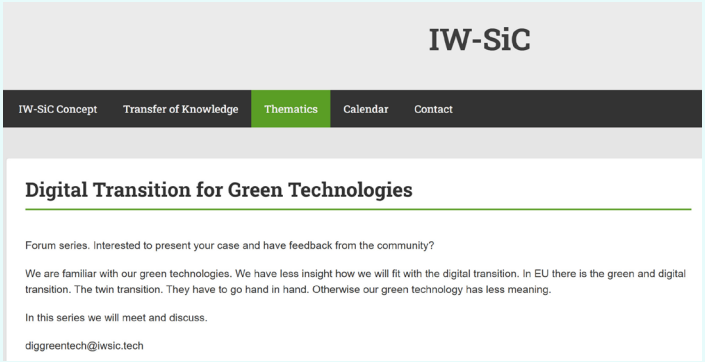
Tokenization of CS-PVT

Value chains must share data to optimize the whole chain. Sharing of data has to be transparent, treaceable and trustable. PVT players from China will not be able to share data.

Sharing data is a way to be more resilient. It offers solution for the geopolitical situation (China). At the same time it offers to create digital assets in addition to the physical asset.
We can come into financially viable exploitation.

The tokenization model can be applied to all deeptech projects.

To be able to do this in value chain, we must transfer knowledge about tokenization. Those who use CS-PVT epiwafers must be part of sharing data and understand the benefit of it. We use IW-SiC and start a forum series in digital transition of green technologies. We have created a pilot for CS-PVT tokenization (GlobalSiC): www.globalsic.world



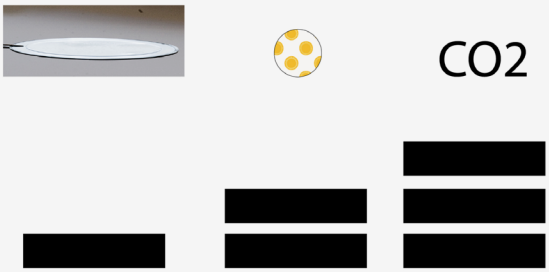
Digital transition

Shared data and digitalization is key.

Semiconductors face price challenges. The CapEx costs are high. Traceability is required.

The shared data can be used to create digital assets of physical products. In addition, there is sustainability asset.

Tokenization can be used to create competitive semiconductor business.



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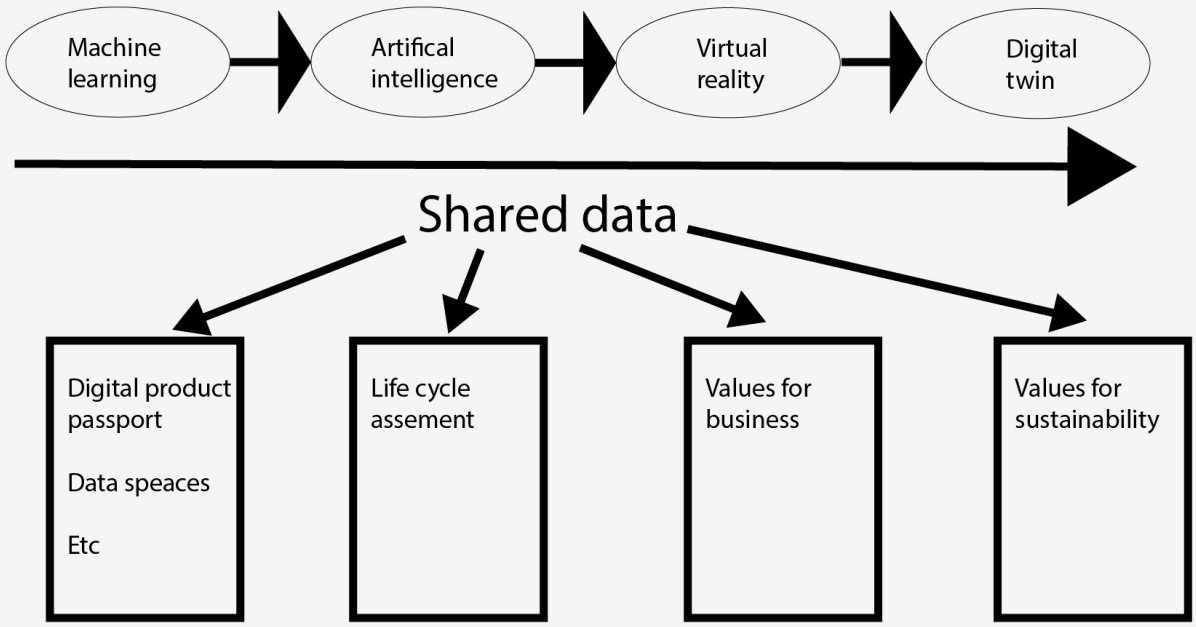
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