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High-performance silicon wafers for demanding applications

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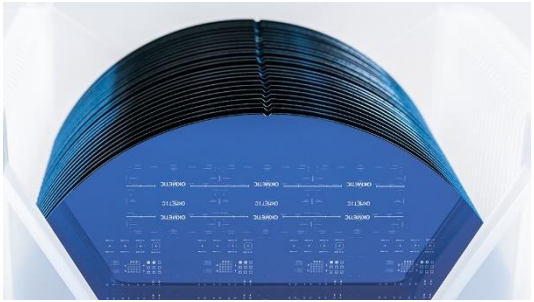
ADVANCED SILICON WAFERS SINCE 1985

Leading supplier of advanced silicon wafers for MEMS, sensor, RF and power applications

Focusing on bonded SOI and high value-add, specialized 150-200 mm wafers

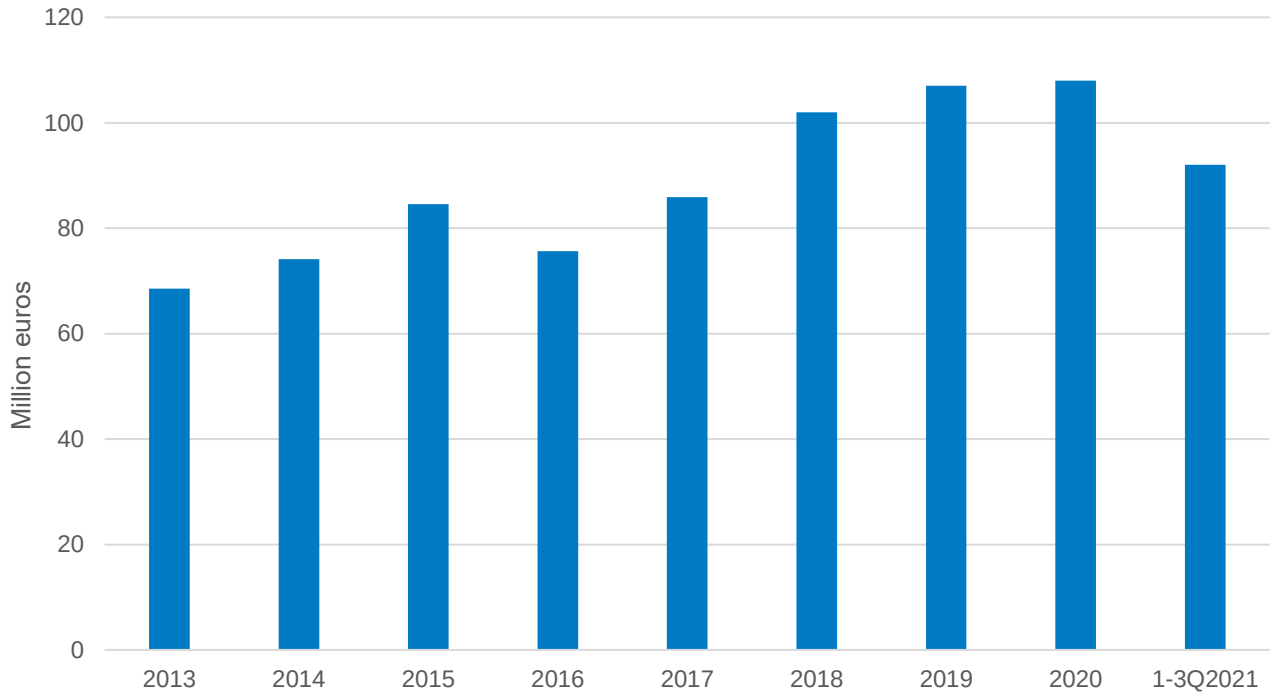
- Magnetic CZ (MCz), A-MCz®
- Very Low and Very High Resistivity (RFSi®)
- Bonded SOI with & without Cavities
- Patterned wafers

Net sales: 108 M€ (2020)
Investments:
> 100 M€ (2017-2021)
Employees: ~ 570



- HQ and production in Finland
- Sales and Tech support worldwide
- #1 wafer supplier for MEMS and sensors
- Nearly 2 million wafers delivered for the RF market, deliveries to double in 2021

Okmetic sales will be record high with 2 digit growth



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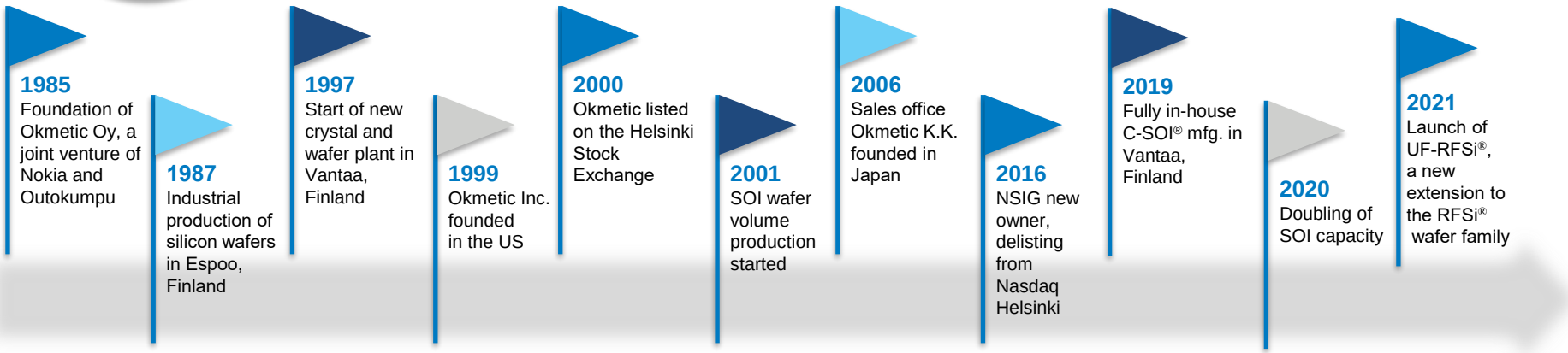
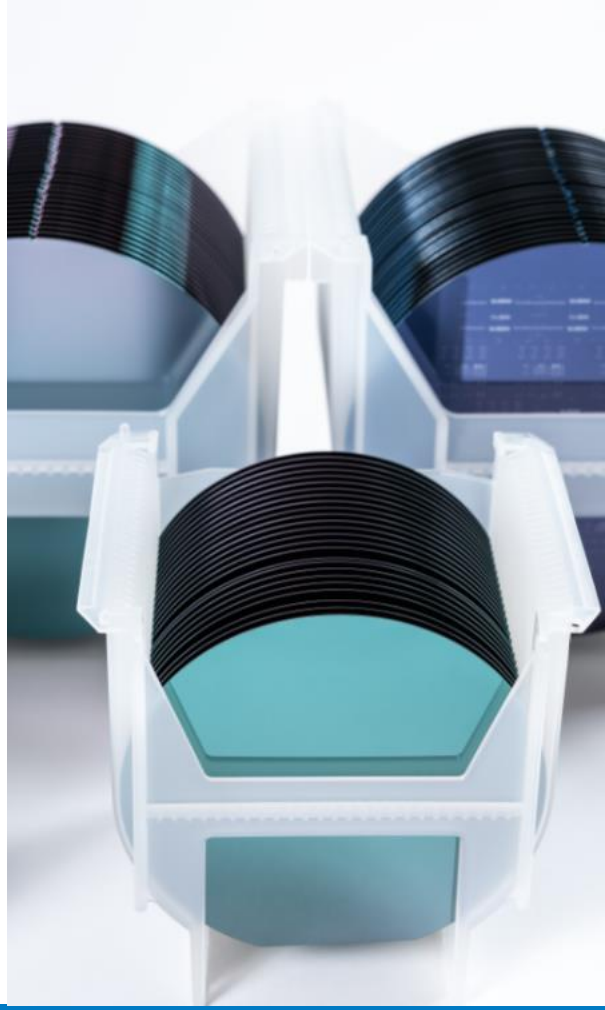
From a laboratory scale pioneer…

…to the world's leading supplier of high-performance silicon wafers

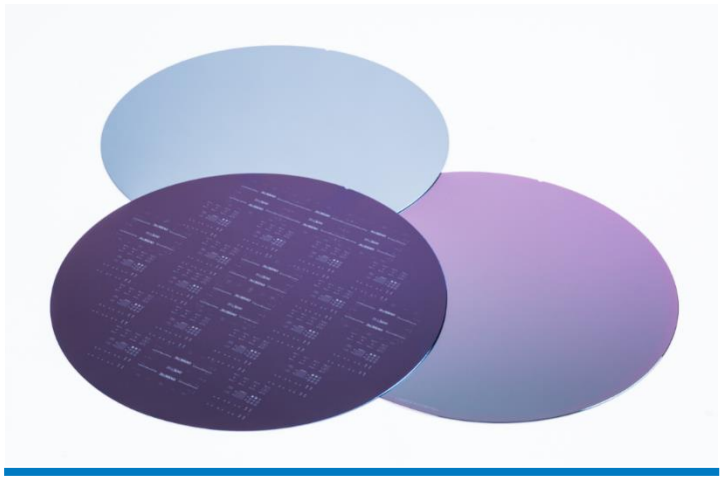


Focusing on the niche markets of semiconductor industry

- **Sensor industry (44% of net sales)**
  - Advanced wafers (SOI and Patterned wafers) for MEMS and other sensor applications
- **RF and Power industries (56% of net sales)**
  - High resistivity RFSi® wafers for RF filters and devices
  - Low and medium resistivity wafers for power applications



Complete set of 150-200mm wafers enable optimized solutions and freedom of design



Crystals

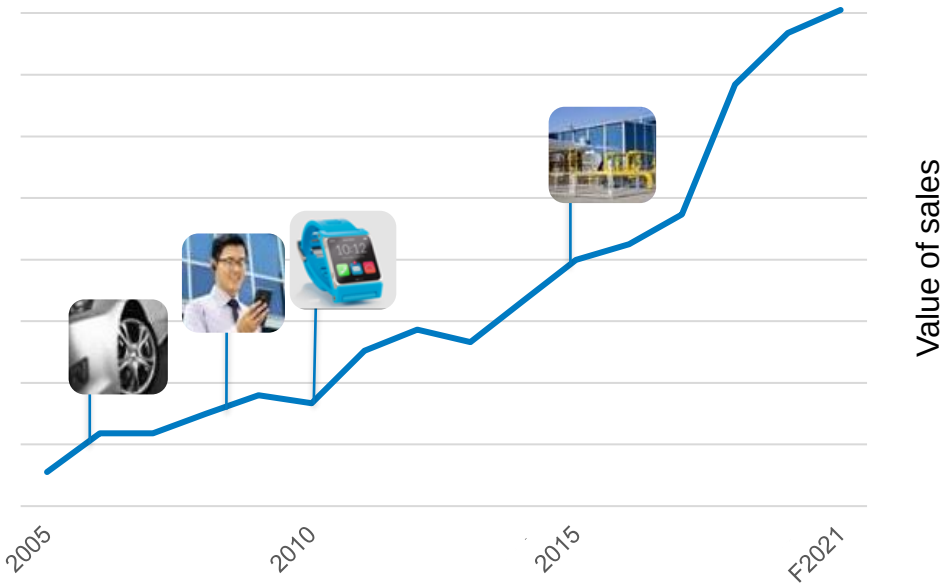
- High resistivities up to and beyond 7 kOhm-cm
- Low resistivities below 1 mOhm-cm
- Different crystal materials, dopants and orientations

Wafers

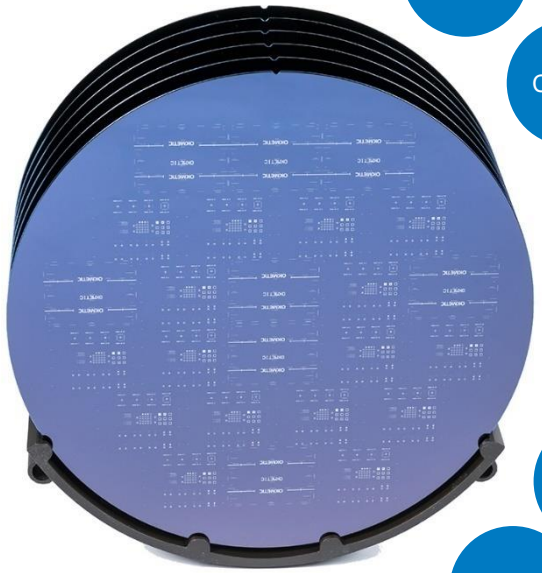
- Bonded SOI (Silicon-On-Insulator) wafer family
- Wafers with built-in patterns
- DSP (Double Side Polished) wafers
- SSP (Single Side Polished) wafers
- RFSi® wafers (High Resistivity for RF devices)

20 years of Okmetic SOI wafers: MEMS continues to be growth driver but use in other markets increasing

2021 Okmetic SOI 20th anniversary
2020 EC-SOI combining E-SOI® and C-SOI® benefits
2019 New C-SOI® production line in 2019
2016 Launch of E-SOI®
2015 SOI wafers for power management
2010 Extremely small pressure sensors and wearable electronics
2009 C-SOI® in volume production
2008 SOI-based silicon microphones
2006 C-SOI® -based inertia sensors for automotive industry
2005 First C-SOI® deliveries
2001 SOI wafer production line started



Bonded SOI product family in 150-200 mm – Solutions for various needs



BSOI
- Fully customizable with starting materials from in-house crystal growth and wafering

C-SOI®
- Wafers with pre-etched cavities

D-SOI
- Two device and buried oxide layers with different thicknesses

E-SOI®
- Highly uniform wafers with device layer thickness tolerance ±0.1 µm

0.3-SOI
- Improved device layer thickness tolerance ±0.3 µm

L-SOI
- Low resistivity SOI device layers

Tailored substrates

BSOI

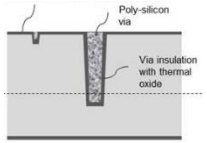
- Fully customizable with starting materials from in-house crystal growth and wafering

C-SOI®

- Wafers with pre-etched cavities

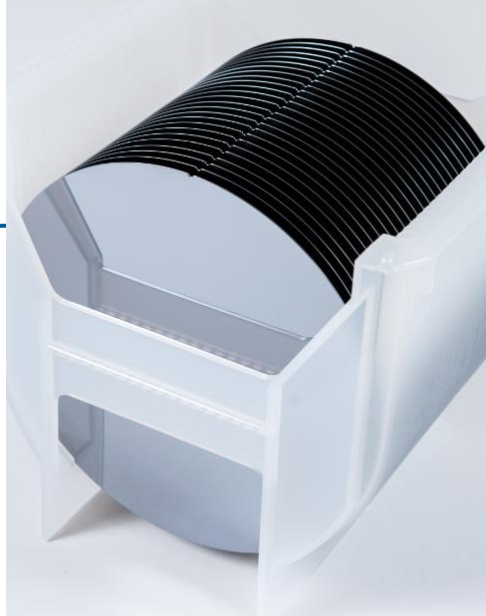
E-SOI®

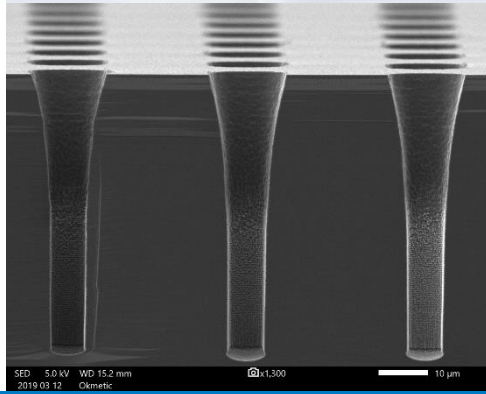
- Highly uniform wafers with tight ±0.1 µm device layer thickness tolerance not dependent on device layer thickness



TSV

- Through silicon vias for sensor interconnects





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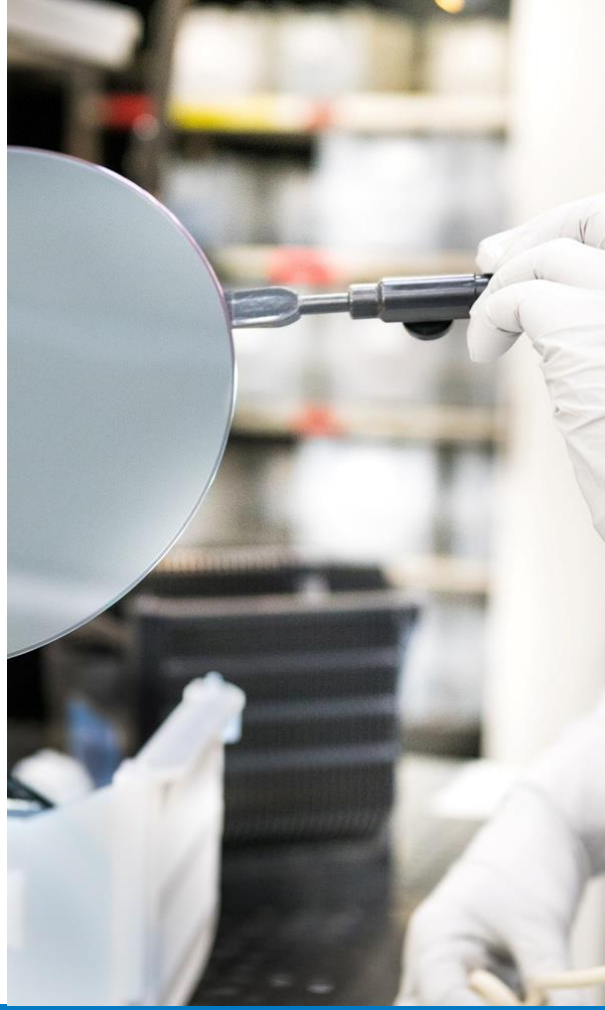
Okmetic SOI adds value to

- Various advanced sensor applications
  - Gyroscopes
  - Silicon microphones
- High Voltage applications requiring (trench) dielectric isolation:
  - Gate drivers (IGBT/Power MOSFET)
  - Embedded technologies, such as Smart Power / High voltage BCD
  - Lateral HV devices



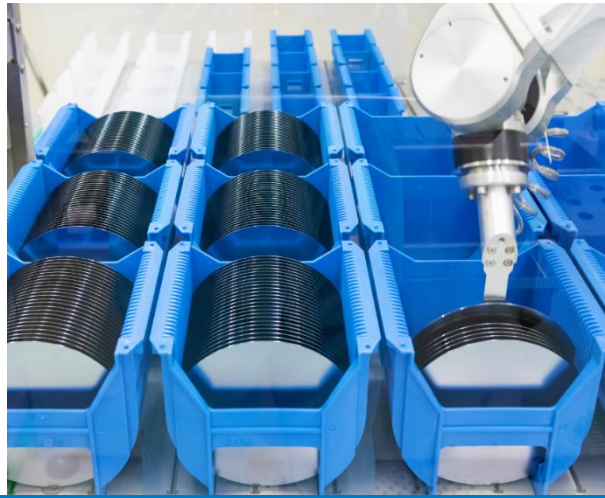
Wafers for Power applications

Product features:

- Arsenic, (red) phosphorus, boron
- Heavily doped wafers reaching the lowest resistivity (down to <1 mOhm-cm)
- Tight resistivity control wafers for IGBT-applications
- SOI wafers for power applications

Typical applications:

- Power MOSFET, IGBTs, CMOS, BiCMOS and Bipolar processes



RFSi® wafer family in 150-200mm – High Resistivity for RF application needs

HIGHRES

- High Resistivity wafers (Low loss **RF IPD** or **Integrated RFFE / RFIC** substrate)

ENG HIGHRES

- Engineered High Resistivity wafers (Added parasitic suppression layer for lowest lost substrate for **RF filter applications**)

UF-RFSi®

- UF-RFSi® (Engineered low loss substrate with Ultra Flat properties for e.g. **Thin Film SAW**)

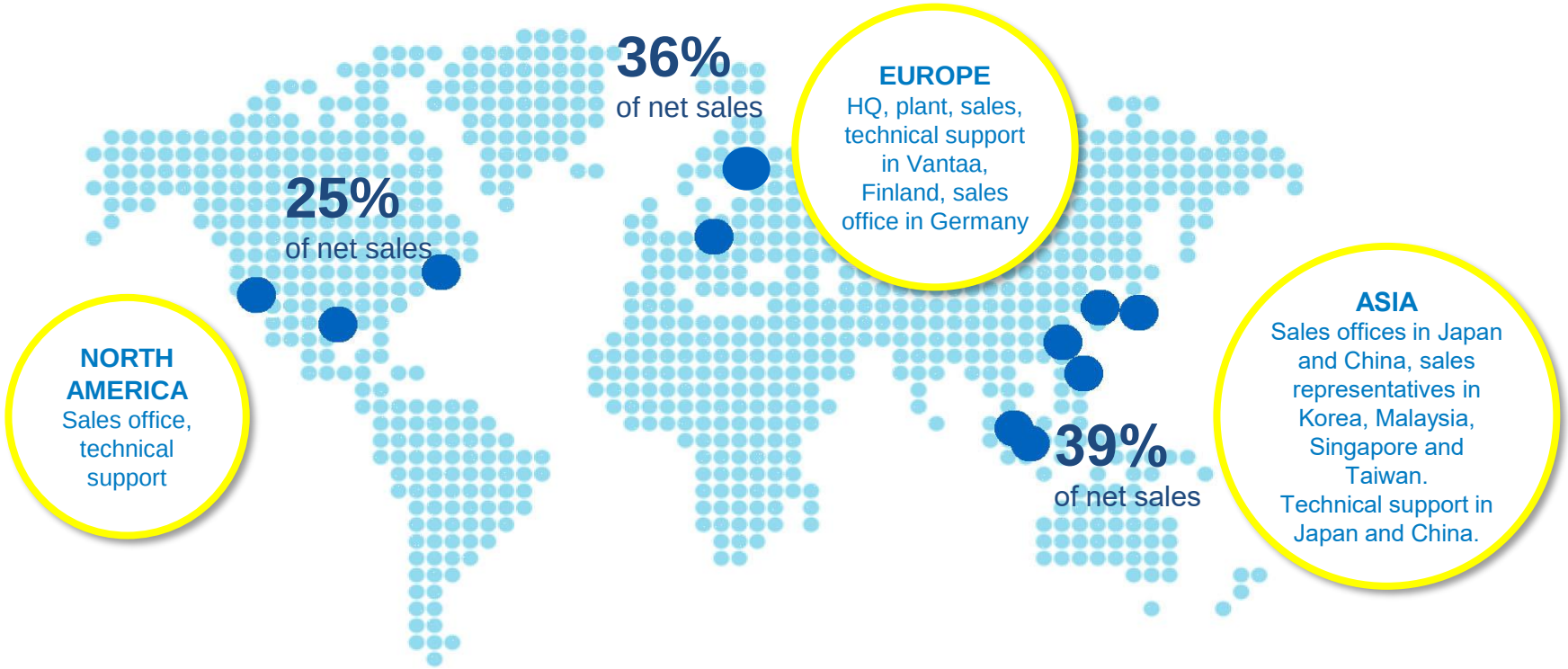
HIGHRES BSOI

- High Resistivity BSOI (Bonded - BSOI or suspended C-SOI® low loss structures per Customer design, e.g. **BAW** resonator)

RF GaN WAFERS

- RF GaN wafers typically extra thick <111> wafers (**GaN-on-Si RF Power device** substrate with advanced stress management)

Supporting customers worldwide



Production facilities – Vantaa plant focusing on SOI and value-added wafers

Vantaa plant, Finland

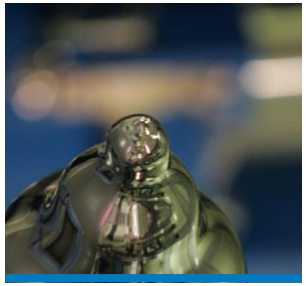
- Crystal growing – more pullers for High Resistivity wafers
- Wafer production
  - High-value 200 mm wafer capacity
  - Fully in-house C-SOI® line
  - SOI capacity doubled in 2019-2021

Wafering subcontractors in Asia

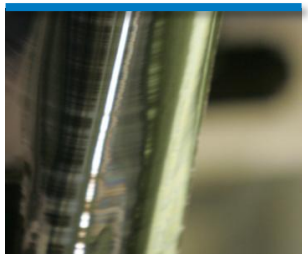
Fab lite model – important part of Okmetic's production strategy for over a decade

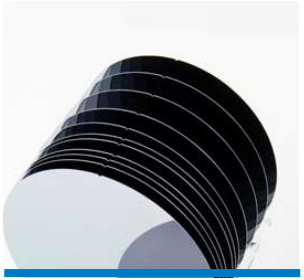
- Okmetic manages the supply chain and customer relations
- Fab lite partners with all quality and environmental certificates
- Customer audits welcome

Okmetic’s strengths

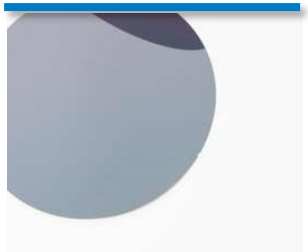


Crystal growing

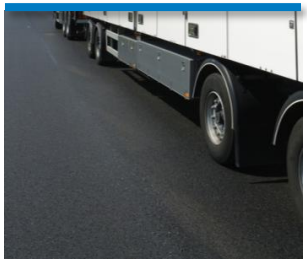




High-performance wafer manufacturing



Agile supply chain



Customer relations

Striving to enhance quality and performance

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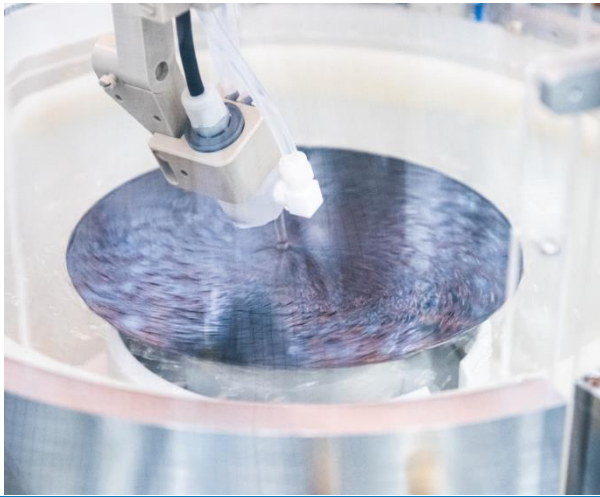
Quality and environmental certificates

- Okmetic has all relevant quality and environmental certificates (ISO 9001, IATF16949, ISO 14001)
  - IATF audit passed in November.
- Okmetic complies with industry's tight regulation (REACH, RoHS directive and the GADSL)
- Quality and environment certification is required also from our subcontractors (ISO 9001, ISO 14001)
- Improvements are driven by Six Sigma and Lean manufacturing tools

ISO 9001: 2015

ISO 14001: 2015

IATF 16949: 2016

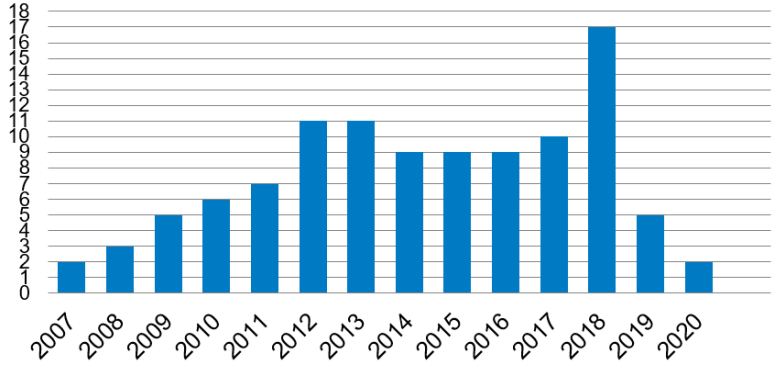


Okmetic quality system has been tested

- **Audit score average 92% in 2019**
- **No serial production audits in 2020**

- **Positive feedback from audits:**
  - Highly motivated and qualified team
  - High management attention for the audits
  - High flexibility of production to comply with broad range of customer requirements
  - Okmetic MES (Manufacturing Execution System)
  - Lean Six Sigma know-how and tools, data management team established

Number of customer audits per year



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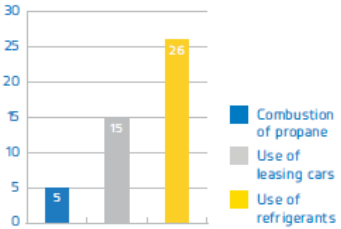
Social responsibility report for 2020

- Social responsibility is an important focus area for Okmetic and reporting is being enhanced.
- New CSR report was published in April and can be found on Okmetic website.

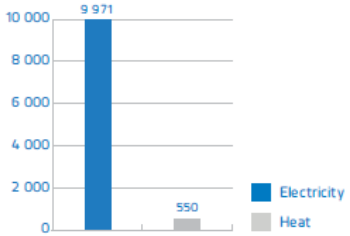
Carbon footprint

Carbon footprint of Okmetic Oy has been calculated according to GHG Protocol (Corporate standard). The operations of the Vantaa plant (Piitie 2, Vantaa Finland) have been included in the calculation. Results represent potential GHG emissions of Okmetic Oy in 2020 calculated on the basis of information provided by Okmetic Oy.

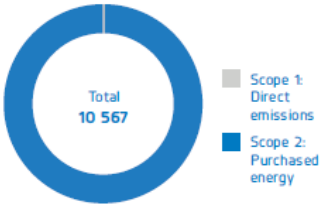
SCOPE 1 (t CO_2 eq.)
Direct emissions – production plant and company owned vehicles



SCOPE 2 (t CO_2 eq.)
Purchased energy – electricity and heat

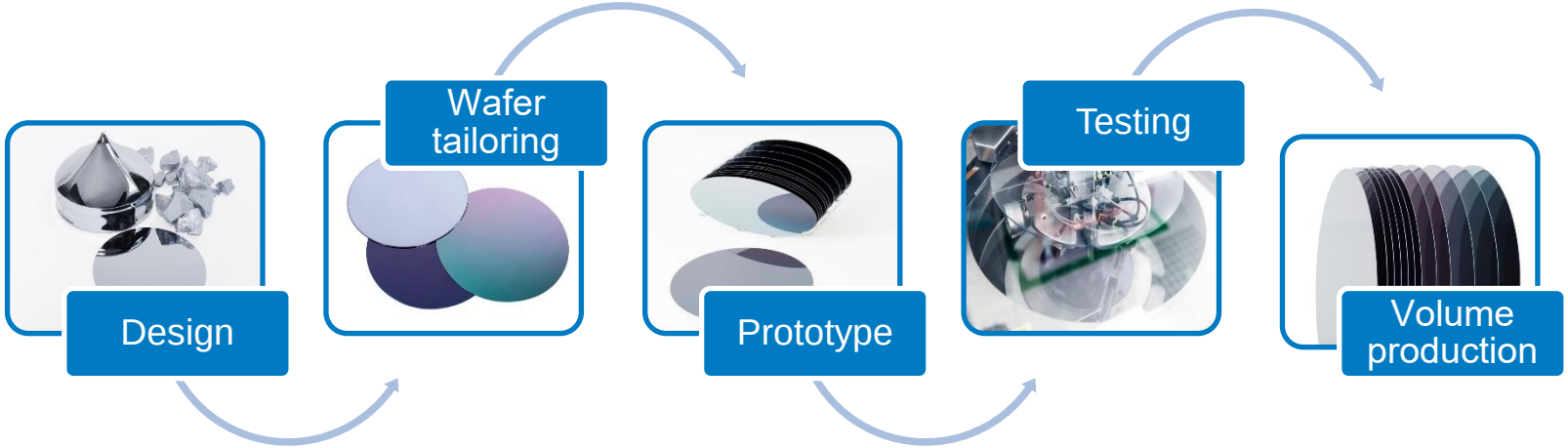


SCOPE 1 AND 2 (t CO_2 eq.)
Direct emissions and purchased energy



Known for commitment and long-term partnership

Benefits: cost reduction, faster cycles, shorter time to market and process streamlining



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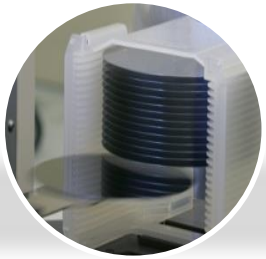
A pioneer and leading supplier of tailored silicon substrates since 1985

1980's

- First (DSP) wafers for pressure sensors

1990's

- Qualified supplier of (DSP) silicon wafers for automotive industry in the US
- MCz process for sensor wafers



2000's

- Silicon microphones (SSP, SOI)
- SOI wafers (C-SOI®) for automotive industry and for inertia sensors

2010's

- Extremely small pressure sensors (E-SOI®)
- Wearable electronics
- Polysilicon TSV
- A-MCz® and RFSi® wafers for RF integration

2020's

- RF filters and devices (UF-RFSi® for TF-SAW)

R&D

focusing on

- Crystal growth
- SOI wafers
- 200 mm wafers

COVID-19 update and other current topics

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COVID-19 hasn’t affected business continuity

- Finland has been reintroducing some restirictions due to rising number of infections. Over 80% of Finnish population over age of 12 have received two vaccinations.
- Pandemic hasn’t had major effects on Okmetic operations
  - Production has been up and running all the time
  - Now less capacity is available due to booming semiconductor market
  - No issues with incoming materials and actions have been taken to ensure supply
  - No logistics problems despite decrease in air traffic
- Installation proceeding well, travel is now easier than before
  - Remote support from tool suppliers
  - Additional actions to get tool suppliers’ teams to Finland
- Frequent communication to customers about COVID-19 effects on Okmetic operations continued
- BCP actions reviewed in all functions

Capacity is tight due to booming semiconductor market, communicating changes in demand is critical

- High demand is expected to continue. Some forecasts estimate even until end of 2023.
- Also Okmetic is experiencing sharp increase in silicon wafer demand.
  - The reduction of cargo capacity, increased logistic and raw material costs and delay of new equipment installations limiting capacity increase are adding the difficulty of the situation.
- Long lead-times, product scarcity, and other supply imbalance challenges for silicon products are expected.
- Communicating anticipated changes in demand continues to be critical in order to manage the material flow.

Okmetic 150mm SSP polishing line renewal project

- Okmetic Vantaa plant has polishing lines separately for 200mm SSP and 150mm SSP
- In addition to Vantaa, Okmetic supplies 150mm SSP via subcontracting.
- Some currently used polishing toolsets in Vantaa are showing their age, and will create business continuity challenges unless renewed.
- Okmetic has made a decision to renew the 150mm SSP polishing line by 2023.

Vantaa 150mm SSP polishing line renewal changing product mix

- After polishing line renewal the 150mm SSP line will primarily be reserved for SOI substrates, thick wafers, Engineered High Resistivity wafers etc.
  - Majority of standard material currently supplied from Vantaa 150mm SSP line are to be qualified primarily to Okmetic subcontracting lines.
  - Expansion of subcontractor usage will continue.
- Transition of polishing line will take time and capacity won’t grow in 2022
  - First tools will be dismounted during 2H21
  - First new tools will be installed during 2Q22. First tools are supporting DSP and SOI products
  - First 200 mm new tools will be installed earliest in 2023, maybe even 2024
- SubC evaluation is highly recommended

Okmetic is actively participating in the semiconductor industry events

- **European Microwave Week**, sponsoring and speaking (15-17 February 2022)
- **MEMS Manufacturing Summit**, sponsoring and speaking (March 2022)
- **MEMS World Summit**, sponsoring (June 2022)

Mars exploration enabled with Murata Finland's sensor built on Okmetic’s silicon wafer

- NASA’s Mars exploration is enabled with state-of-the-art sensor technology by Murata Finland using Okmetic’s advanced silicon wafer as a platform.
- Murata Finland’s SCA100T dual-axis inclinometer is used in NASA’s Ingenuity helicopter, which arrived to Mars with the Perseverance rover in February 2021.
- The purpose of the inclinometer is to eliminate the inclination errors of the separate IMU through calibration before each flight to ensure flight accuracy.
- The signal produced by the sensor must be extremely precise as on Mars the inclination signal is about one-third of the signal measured on Earth.

NSIG – Investor for Okmetic

Okmetic is part of Chinese NSIG since 2016

Crystal and prime wafer production

Epi and smart cut processes

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150-200 mm wafers incl. SOI	300 mm wafers	150-200 mm wafers	200-300 mm wafers NSIG owns 10-12% of shares

National Silicon Industry Group (NSIG) is a China-based holding group engaged in the investment and development of semiconductor materials and equipment industry. NSIG is listed on the SSE STAR market, China's new Nasdaq-style tech board.

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