Freiburg and Glenrothes Locations

“Preserving what we value”

TDK-Micronas

Environmental *News* 2019

to EMAS/ISO 14001

Environmental Protection beyond Company Boundaries

Editorial

In the last twelve months, the subject of climate and environmental protection has rapidly gained in importance – not only in Germany, but worldwide. Against this background, it is good to know that both TDK-Micronas as a German semi-conductor company and TDK Corporation as a globally operating group with production facilities in all parts of the world are following a long-term plan with the aim of meeting the Paris climate targets by 2035, the year of TDK's 100-year anniversary. TDK-Micronas will make its contribution to this. You can find an overview of our environmental projects on page 4.

Integrated into the chain of automotive suppliers, TDK-Micronas has stood for top-class sensor quality for many years among leading OEMs. At present, the most important factor affecting change in the automotive industry is the large number of increasingly strict legal regulations, especially in the field of emissions. Car manufacturers must comply with the mounting demands on driving comfort, engine performance and driving enjoyment, combined with the simultaneous call to reduce fuel consumption and lower carbon dioxide (CO_2) and nitrogen oxide (NO_x) emissions. The electronics in modern-day automotive applications needs sensors with ever higher integration density while meeting ever increasing demands on ruggedness, reliability and energy efficiency at the same time. Sensor manufacturers such as TDK confront this constant innovation and cost pressure with tailor-made sensor solutions for a variety of automotive applications.

The future of modern vehicles lies in electromobility. The change to mobility is creating space for product innovations in the sensor segment. As a true visionary, TDK has taken advantage of this development as an opportunity to create from a proven technology an innovative product for electric and hybrid vehicles (xEV). The new current sensor CUR 423x uses synergies within the TDK Group and combines TDK's TMR (tunnel magneto-resistance) sensor technology with the TDK-Micronas' know-how in the field of Hall effect-based current measurements. The new product is a TMR-based current sensor (based on the tunnel magneto-resistance effect) for high-current applications up to 1,200 A, which can be used, for example, for highly accurate battery monitoring in electric vehicles. TDK's TMR technology has already proven itself in many other automotive applications and is now paving the way for innovative current measurements.

Where environmental pollution is concerned, we cannot ignore the fact that the Earth is facing a problem. We must all do our part to protect Nature – and that also means looking beyond the company's boundaries. In spring 2019, TDK-Micronas organized a garbage collection campaign in Freiburg's northern industrial region. During the two-hour cleaning-up operation, the participants collected waste thrown carelessly by passers-by on the side of the road. They also found that some of the litter had come from local companies in the Freiburg industrial zone. During the delivery or dispatch of goods, for example, packaging material such as plastic film or cardboard boxes are picked up by the wind and spread across the surrounding vegetation. I am pleased to say that, in our company, we have many dedicated employees who are actively committed to work for a future worth-living on our planet.

We also want to sensitize future generations at TDK-Micronas to the topic of environmental protection. For this reason, our trainee program has, since June 2018, included an Innovation Academy training project that encourages the growth of more flowers and plants in industrial areas. The aim is to also educate the trainees on topics that are not normally part of their training program, such as nature and species protection, horticulture and nutrition. In 25 months, through chaired workshops, a plan is to be drawn up for the company to improve ecological quality. In May 2019, as part of this project, our trainees created a flower meadow in front of the reception building. The wild flowers they sowed are not only pretty to look at, they also need much less water. And they provide a home and source of food for numerous domestic insect species.

The high awareness of our employees of their responsibility for the environment is not only a driving force in the development of innovative products, it also helps with their resource-saving production at the Freiburg site. In production, TDK-Micronas also endeavors to exceed the legal requirements on environmental protection. Exemplary projects for saving energy are the company's own photovoltaic unit and the combined heat and power unit that went on stream in 2014. The latest project is now being built directly at the heart of our wafer production: Through the expansion of an improved wafer cleaning system, a considerable amount of electricity, chemicals and water will be saved in the next few years. You can read more about this project on the following page

Through continuous improvements and consistently implemented measures for greater environmental protection and saving of resources, TDK-Micronas is actively involved in realizing TDK's corporate vision and meeting the Paris climate targets. I am confident that we are on the right track.

Günter Weinberger
Chief Executive Officer TDK-Micronas

Environmental Projects

Resource and Energy-Efficient Cleaning of Wafers

In the course of several hundred individual physical and chemical processes, electronic circuits or silicon chips are produced on high-purity, monocrystalline silicon disks, known as wafers. The minimum structural sizes are below 0.5 µm and thus around one hundredth of the diameter of a human hair. They are thus only just about visible under an optical microscope.

During the production in the front end, between several thousand and over 20,000 Hall sensors are formed on one wafer, depending on the type. Every Hall sensor has between 5,000 and 100,000 transistors, resistors, capacitors and diodes.
The processes of wafer production are performed in a repeating sequence of coating, lithography, etching, implantation, cleaning and high-temperature processes to create the structures and to adjust the electronic properties of the active elements.

Because of the small structural sizes, the wafer processing takes place in a clean room that allows a maximum of one particle greater than 0.5 µm in one cubic foot (35 ℓ) of clean room air. Apart from that, the wafers have to be repeatedly cleaned during the course of the process. During this operation, it has to be ensured that the wafers are free of contamination such as particles or organic residues prior to any high-temperature processes. Even minimal contamination on the surface of the wafer could, during the subsequent high temperatures between 900 °C and 1,150 °C, penetrate into the silicon crystal and destroy the function of the electronic circuits.

For cleaning the wafers, an improved spray-cleaning process was introduced in 2017 with the start-up of a new plant. With the previously used cleaning processes, the wafers were placed in a bath and permanently rinsed with high-purity water. For the cleaning, the necessary chemicals were injected into the water over a defined period. The consumption of high-purity water was correspondingly high. To accelerate the chemical reactions, the baths had to be permanently heated. With a high flow of water, this is naturally accompanied by high electricity consumption.

The wafer cleaning team from l. to r.: Thomas Meidlinger, Michele Felice, Birgit Prien, Marianne Rosenau, Yvonne Maier, Frank Osiander, Vitalij Frank, Thomas Erath

In the new spray cleaner, on the other hand, the necessary chemicals are sprayed in small doses directly onto the wafers. After a defined reaction time they are then removed again using ultra-pure water and this cleaning process is repeated several times.

The cleaning is supported by the use of ozone, which is produced immediately ahead of the process in an ozone generator and is completely destroyed again directly after the process. It is possible here to dispense entirely with the organic solvent isopropanol for drying the wafers because the drying takes place by rotating the wafers in a hot inert gas flow in the process chamber.
Overall, the amount of media used for the cleaning (water, electricity, chemicals) using the spray process is reduced by over 90 % compared with the bath process.

The improved wafer cleaning process was first successfully introduced in a semi-automatic unit. In the next stage, use was made of a fully automatic spray cleaning with a higher throughput. In the final expansion stage, three machines with immersion baths will be replaced. Apart from the considerable water, chemicals and energy savings, the new cleaning units also require a much smaller clean room area.

Thomas Meidlinger
Module Manager Hot Implant
Waferfab

Overview of Current and Planned Projects

Freiburg and Glenrothes Locations

Environmental Projects

Subject	Goal	Measure	Dept. responsible	2018	2019
Energy-management	Electricity savings of approx. 10,000 kWh / year (2 t CO_2 / year)	Electricity saving by relocation of hazardous substances in the warehouse and optimization of the fan efficiency	Plant Engineering and Facilities	○	○
	Electricity savings of approx. 10,000 kWh / year (2 t CO_2 / year)	Switch to LED lighting technology in buildings		●	●
	Natural gas and electricity savings of approx. 36,000 kWh / year (7 t CO_2 / year)	Roof renovation office building 3a and part of building 7 (both rented areas)		●	
	Natural gas and electricity savings of approx. 16,600 kWh / year (3 t CO_2 / year)	Renovation of windows in building 11		●	
	Electricity savings of approx. 53,000 kWh / year (18 t CO_2 / year)	Electricity savings through new generation of end-testers and parallel 8-fold test in the final test	Backend Test in Freiburg and Glenrothes	●	
	Electricity savings of approx. 13,000 kWh / year (2 t CO_2 / year)	Electricity savings through new generation of end-testers and parallel 8-fold test in the final test			●
	Electricity savings of approx. 41,000 kWh / year (8 t CO_2 / year)	Capacity increase with faster die bonders	Backend Assembly	●	
	Electricity savings of approx. 147,000 kWh / year (72 t CO_2 / year)	Switch to LED lighting technology	Testcenter Glenrothes	●	●
Resource-management	Savings of approx. 25,000 m^3 / year of municipal water and 85,000 kWh / year electricity (17 t CO_2 / year)	Utilization of groundwater for cooling purposes with the continued use of installed sections of the groundwater remediation facility	Plant Engineering and Facilities	●	
	Annual savings of approx. 42 t chemicals, 10,000 m^3 water and 315,000 kWh electricity (53 t CO_2 / year)	Optimized wafer cleaning through semi-automatic spray cleaner	Waferfab	●	
	Annual savings of approx. 49 t chemicals, 5.200 m^3 water and 630,000 kWh electricity (108 t CO_2 / year)	Optimized wafer cleaning through fully automatic spray cleaner			●
	Annual savings of approx. 15,000 m^3 water	Water savings through installation of a new heat exchanger		●	
Health protection	Encourage health care among the workforce	Health campaigns: • Industry bikes in Industriegebiet Nord • Course for successfully losing weight • Tips on mindfulness topics • Provision of fruit bags • Conflict mediation • Medical check-ups and running training to take part in the Business Run • Support to compete in the Freiburg (half) marathon • Participation of over 250 employees in Hansefit • Health truck of health insurance company	Working group on health protection; campaign team „We for us"; company medical team	●	●

Key: ● Implementation ○ Extension ● Completed, goal achieved

TDK-Micronas within the MSBG of TDK Corporation

Facts and Figures

FACTS AND FIGURES

TDK in T123

- Sales of around JPY 1,382 bn.
- 105,000 employees worldwide

Magnetic Sensors Business Group Vision:
"Be a World No. 1 Magnetic Sensor Supplier."

TDK-Micronas in T123

- Part of the Magnetic Sensors Business Group and the Competence Center for magnetic field sensors of the TDK Group
- Operational management and production in Freiburg, Germany
- Design center in Haar (Germany)
- Test center in Glenrothes (Scotland)
- 1078 employees worldwide, of which 890 in Freiburg
- Investment and ongoing expenditures in corporate environmental protection in Freiburg:

Investment and ongoing expenditures in company environmental protection (waste management, water protection, soil decontamination, noise reduction, air pollution control, climate protection, nature protection, landscape conservation, energy generation and control) in Freiburg

	Million Euros
2015	1.6
2016	1.7
2017	1.8
T123	0.8

Test center in Glenrothes

- 87 Employees
- Energy consumption 2.8 GWh, equivalent to 1,358 t CO_2
- The important environmental aspect is the electricity consumption and the resulting CO_2 emissions.
- Most important waste fractions: 2.1 t paper and board, 1.8 t plastics and 13.5 t metals into recycling; 2.5 t of general waste for disposal
- No notifiable accidents

Certificates

ISO 14001 Freiburg

ISO 14001 Glenrothes

EMAS Freiburg

Magnetic Sensors Business Group Locations

Environmental Data

Freiburg Site

Environmental data in T123

Below are the core indicators for the Freiburg operating segment. By publishing these figures, we comply with the requirements of Regulation (EC) No. 1221/2009, the so-called EMAS regulation.
The bar charts show the absolute consumption figures, while the linear diagrams show the consumption normalized to the total gross value added – the so-called "core indicators". The core indicators themselves are related to the reporting period of this issue of EnvironmentalNews.
Up to 2017, the reporting period was always the calendar year. Starting with T122 (1 April 2017 to 31 March 2018), we now adjust the reporting period to the fiscal year of TDK.
The consumption figures for the missing first quarter of 2017 are shown at the appropriate place on each chart. The concluded fiscal year T123 began on 1 April 2018 and ended on 31 March 2019. Normalization to the total gross value added ensures the required comparability of the consumption data over the last four years.

Primary energy factors, CO_2 emission factors, data on renewable energies of the power supplier and accident figures from the employers' liability insurance association are only available for the calendar year. Investment and ongoing expenditures also relate to the calendar year, as do data that are sent recurrently to the statistical office or federal office.

Energy consumption

The total direct energy consumption from electricity and energy sources and the proportion of consumed renewable energy are shown in the following table. The energy consumption taking into account the relevant primary energy factors (PEF) is shown in the bar charts below.

Year	Total Energy Consumption in GWh	of which from Renewable Energy Sources in GWh (Proportion of Total Energy Consumption)
2015	95.6	25.4 (27%)
2016	103.7	24.7 (24%)
T122	103.9	22.5 (22%)
T123	99.7	23.5 (24%)

The photovoltaic unit generated around 237.5 MWh in the reporting period T123.

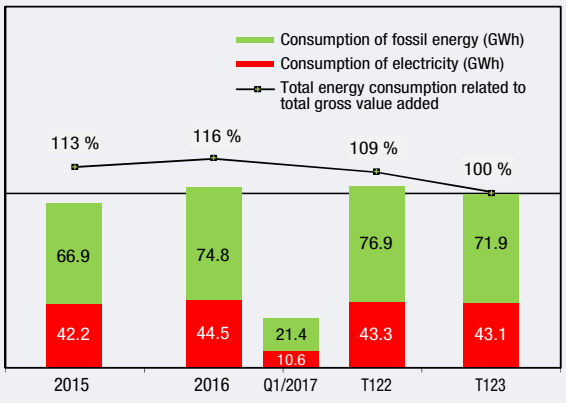
TDK-MICRONAS GMBH FREIBURG

Note: The data for chemicals and process gases for the reporting period T123 has been corrected.

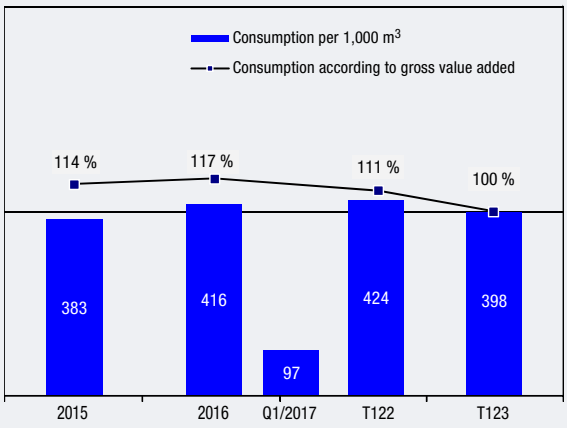
Absolute consumption

Consumption related to the total annual gross value added in %, normalized to the fiscal year T123

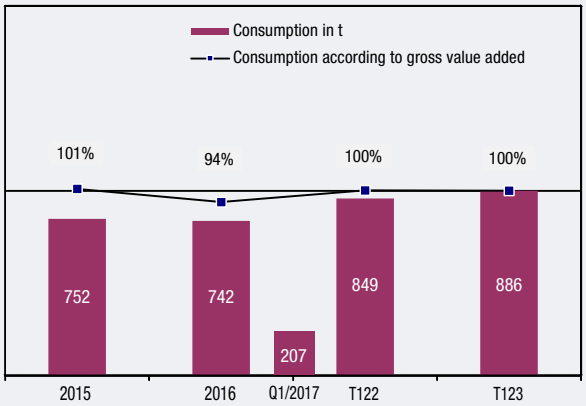
Consumption of electricity and fossil energy sources, taking into account the respective primary energy factor.



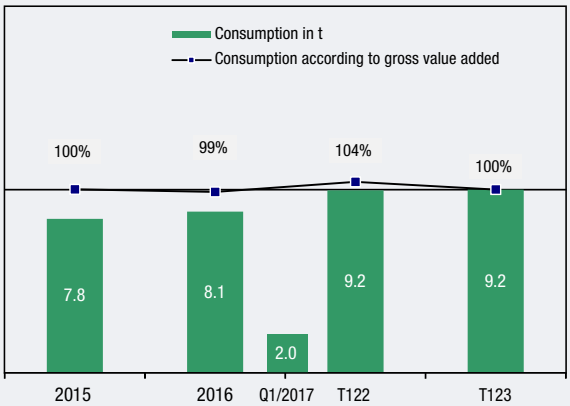
Water



Chemicals



Process Gases



*The members of the emergency response team are **thanked** for their dedication:*

from l. to r.:
Kay Gauglitz,
Markus Behrendt,
Jan Laube,
Jürgen Spillmann,
Sebastian Becker,
CEO Günter Weinberger

Environmental data in T123

Other environmental data:

- The natural gas consumption (for heating and for electricity and heat generation in the co-generation unit) in T123 of just under 65 GWh according to GEMIS (Global Emissions Model for Integrated Systems) corresponds to equivalent emissions of 95 kg of SO_2, 5.3 t NO_x and 66 kg of dust, which are regarded as insignificant environmental aspects.
- The sealed area (core indicator biological diversity) is 39,200 m^2, the unsealed area is 12,300 m^2.
- The recycling quota for the entire waste produced is very high at 99.8 %.

Occupational safety and health protection

At TDK-Micronas in Freiburg, the accident figures are always below the comparative index of the employers' liability insurance association. Compared with previous years, however, there were significantly more accidents at work in the T123 period covered by the report, namely seven notifiable accidents. These were hand and leg injuries caused by squeezing, knocking or twisting that led, for example, to pulled tendons and sprains without any permanent damage.

Fire prevention and emergency management

In the past, TDK-Micronas has invested a lot of money in fire prevention (e.g. fire alert system, sprinkler units, inert gas extinguishers, leakage and gas sensor systems, central hazard alert system in the alarm center, which is manned 24/7. The alarm system for the emergency task forces is tested regularly, and, in particular the members of the company's internal task force have to prove their skills in frequent exercise drills.

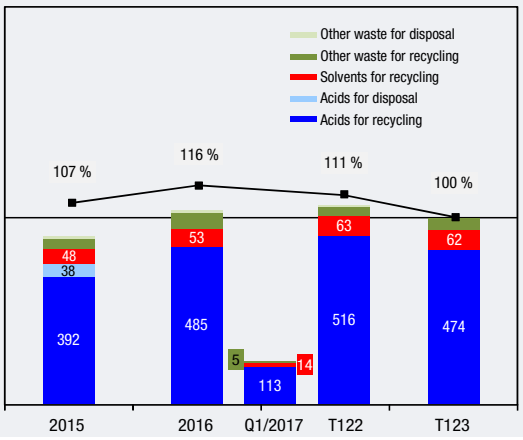
Recently, a waste chemical was accidentally released through a technical fault in one of the rented halls in our Technology Park. After activation of the alarm chain, the task force immediately shut off the chemical and energy supply to the corresponding plant. Through the action of the TDK-Micronas emergency response team under the leadership of Kay Gauglitz, and with the help of the necessary personal protective equipment, building damage was kept to a minimum, bodily injury was prevented and any effects "beyond the company boundaries" were avoided.

WASTE

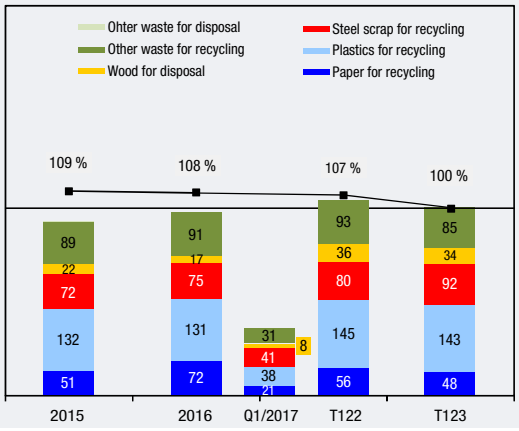
Waste in t

Waste referring to gross value added in %, normalized to the year T123

Hazardous waste (t)

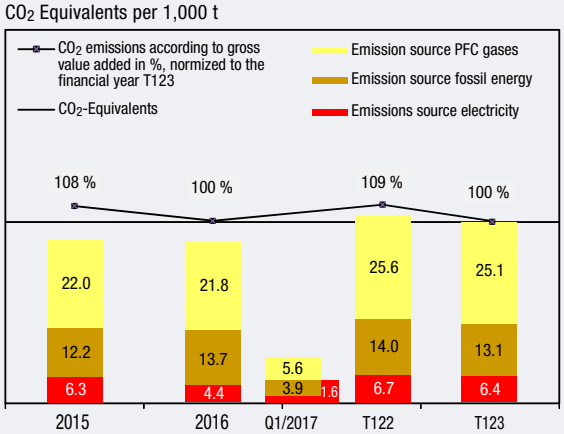


Non-hazardous waste (t)



CO_2 EQUIVALENTS

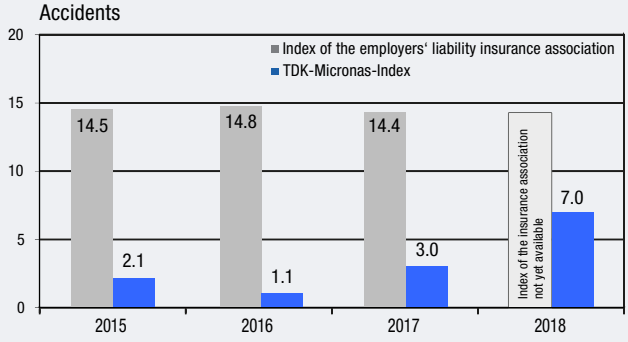
CO_2 Equivalents per 1,000 t



ACCIDENTS

Notifiable accidents per 1,000 employees in the last four calendar years

Accidents



EMAS
Verified environmental management
DE-126-00053

Environmental Statement

The next consolidated Environmental *Statement* will be submitted for validation during July 2020 at the latest.

Environmental Verifier / Environmental Verifier Organization

The authorized environmental verifier / environmental verifier organization are as follows:

Dr.-Ing. R. Beer (Permit No. DE-V-0007)
Intechnica Cert GmbH (Permit No. DE-V-0279)
Ostendstrasse 181
90482 Nuremberg

Validation

Dr. Reiner Beer, with EMAS environmental verifier registration number DE-V-0007, accredited or licensed for the scope 26.1 (NACE Code Rev. 2), Manufacture of electronic components and boards, declares to have verified whether the site as indicated in the consolidated environmental statement with registration number D-126-00053 meets all requirements of Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organizations in a community eco-management and audit scheme (EMAS), supplemented by Regulation (EU) No 2017/1505 amending Annexes I, II and III to Regulation (EC) No 1221/2009.

By signing this declaration, I declare that

- the verification and validation has been carried out in full compliance with the requirements of Regulation (EC) No 1221/2009,
- the outcome of the verification and validation confirms that there is no evidence of non-compliance with applicable legal requirements relating to the environment,
- the data and information of the updated environmental statement of the site reflect a reliable, credible and correct image of the site activities, within the scope mentioned in the environmental statement.

Nuremberg, July 25, 2019 — Dr. Reiner Beer, Environmental Expert

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