



Sustainability@Fraunhofer - Research for a better world

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Sustainability is important for us

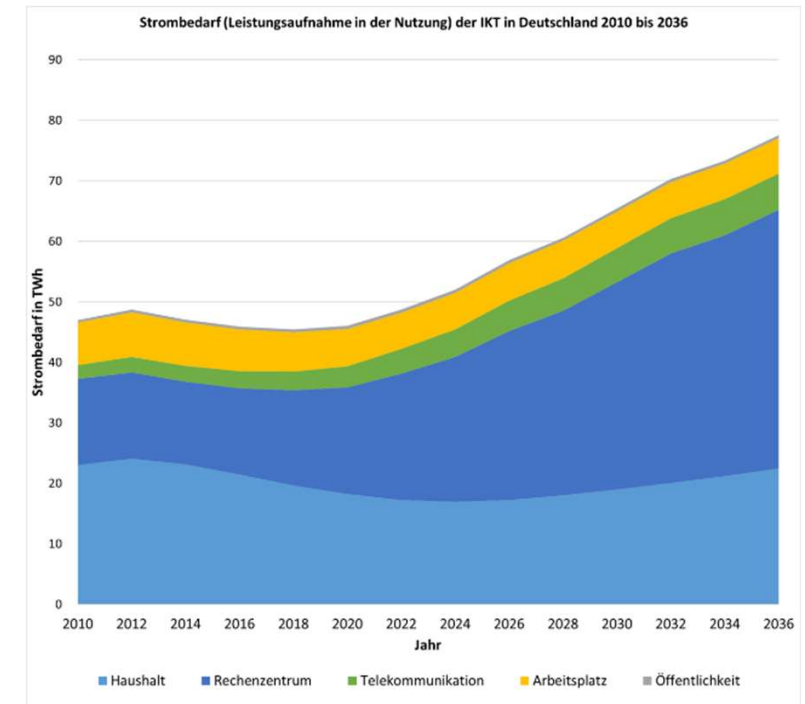
Focus on environment

Sustainability includes: **Environment**, Social and Governance

Focus on environment

Electricity consumption is rising. Increase in electricity consumption through ICT in Germany, **2024 ~ 50 TWh, 2033 ~ 75 TWh**

EU Semiconductor industry has also huge impact on **water consumption**, creation of hazardous waste and pollution of air



» The Executive Board of the Fraunhofer Gesellschaft has set the goal of reducing the organization's own emissions by 55% by 2030 and compensating for any remaining emissions. By 2045, Fraunhofer aims to operate in a climate-neutral manner.«

Sustainability @ Fraunhofer

Our three focus topics



Responsible corporate governance: Fraunhofer climate strategy

Technical Action Fields of Fraunhofer climate strategy



Energy

- Own power generation, for example by installing PV solar plants
- Cost-effective green electricity procurement
- Introduction of energy management systems according to ISO 50001
- Energy efficiency and climate action networks



Buildings/properties

- Refurbishment / energy efficiency measures
- Gebäude-Energierichtlinie (Fraunhofer Directive on Energy Performance of Buildings)
- Green heat energy: geothermal systems
- Optimized cleanrooms



Mobility

- Jobtickets (employee transit passes)
- LamA — Charging at Work charging infrastructure
- Electric cars for the vehicle fleet
- Climate-friendly business trips
- Offsetting air travel



Material flows

- Identifying sources of emissions that have not previously been covered
- Focus: reducing emissions from the use of climate-impacting gases and substances as well as coolants
- Sustainable procurement

Research for a better world: Green ICT@FMD

Overview

Project partner

All 13 institutes of

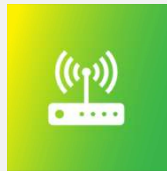


**Forschungsfabrik
Mikroelektronik**
Deutschland

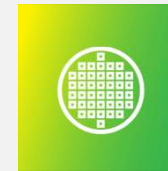
Technology Hubs



Sensor-Edge-Cloud



Communication Networks



Microelectronics Production

Complementary Activities



Camps and Award



Standardization



Open Platform



Green ICT Space



Professional
Development



Green ICT Connect



Accompanying
Research

Research for a better world: Green ICT@FMD

Service Portfolio Hub 3: Microelectronics Production – Range of topics



Processing



Cleanroom &
infrastructure



Energy
management



Material substitution

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Service Portfolio Hub 3: Microelectronics Production

Range of topics

Technological offers

Life cycle assessment offers Environmental potential analysis



Material substitution

- ◀ EKC265 Substitution for cleaning Si wafers after the Bosch Si etching process and other cleaning options
- ◀ Process optimization with slurries from less critical sources or materials, advice on recycling tools, characterization on test structures
- ◀ Consulting on FAN gas installation, development and optimization of the plasma cleaning concept
- ◀ Alternative materials to NMP: testing possibilities through extensive knowledge using different characterization techniques

- ◀ EKC265 alternatives: Fluorides, amines, hydroxylamine and pyrocatechol-free, low process temperature, without rinsing with isopropanol
- ◀ Replacement of Ce- by SiO₂-containing slurries; reduction of water consumption in the post-process, recycling and re-use of slurries, determination of consumption and carbon equivalents
- ◀ Replacement of the cleaning gases C₂F₆ and NF₃ with FAN
- ◀ Process evaluation without NMP

Evaluation of material and energy consumption for entire technology processes in terms of consumption vs. expenditure

Research for a better world: Green ICT@FMD

Stripping Demo in collaboration with BASF

Process: Remove photoresist after lithography using chemical strippers

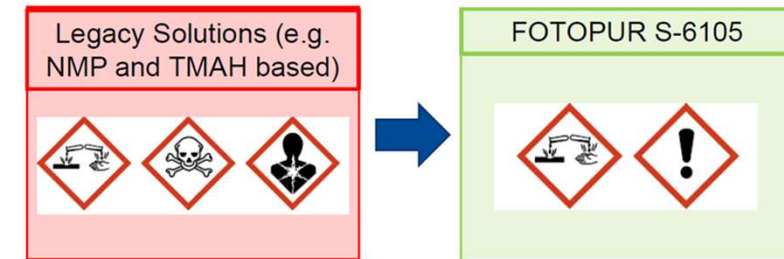
Action: Substitute

- Current chemicals (contain NMP and TMAH):

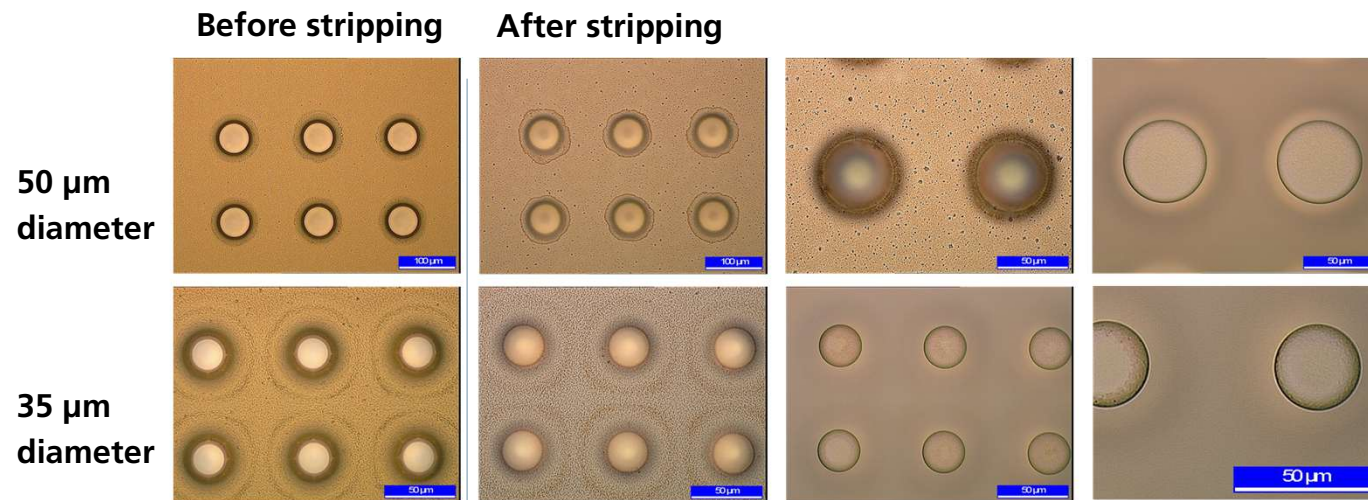
- Present environmental hazards
- Pose reproductive health risks

- Test alternative solution:

- EHS-friendly formulation
- Safe organic solvents
- Effective stripping performance



Action: Substitute NMP with the non-toxic alternative chemical



- Two ASSID bumps designs tested after Cu-ECD
- After 2 min at 70 °C completely removed 50 µm and 70 µm PR

Figure: left side images before stripping, next three images after stripping with different Focus (seedlayer, pillartip)

Source: M. Myndyk (Fraunhofer IZM-ASSID)

Fraunhofer Contributions



2025

WP3: Environmentally friendly materials alternatives



Development of a sustainable DRIE;

Replacement of PFAS Material in Packaging for Sensor Application

Plasma wafer stripping process with climate friendly FAN gas mixture

WP4: Minimization of waste and emissions



Improving abatement efficiency of legacy equipment

Novel Abatement Systems and Waste reduction in the CMP process

WP5: Material scarcity impact mitigation



Low scarcity risk back-end-of-line metals in Si CMOS

Rare earth waste recycling in CMP



Co-funded by
the European Union



Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAFR
State Secretariat for Education,
Research and Innovation SERI



EU Project GENESIS WP4

Minimization of waste and emissions (FhG)

**4.1 Gas
abatement in-
lab and lab2fab
qualifications**

BOSCH

**4.2 Aqueous
abatelements and
capture systems - in-
lab and lab2fab
qualifications**

ST-I

**4.3 Waste
recycling & re-
use solutions**

SOITEC

WP4 overview



12

Subtask



26

Partner



2

Objectives



Co-funded by
the European Union



Project funded by

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation

Federal Department of Economic Affairs,
Education and Research ESR
State Secretariat for Education,
Research and Innovation SERI

Objectives WP4



Increase gas and aqueous waste abatement efficiency



Increase waste recycling and reuse



Co-funded by
the European Union



Project funded by

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Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EARE
State Secretariat for Education,
Research and Innovation SERI

EU Chips JU Project GENESIS

First results of WP 4 in cooperation with partners

CMP Slurry recycling

- CMP: Chemical mechanical polish (of a wafer)

Objectiv: Several concepts for waste reduction in the CMP process shall be qualified at industry level and developed further.

First results:

- Removal rates of both slurries (fresh and recycled) are proportional for all tested parameter combinations (pressure, velocity, time)
- Nearly equal performance when solid content is matched"

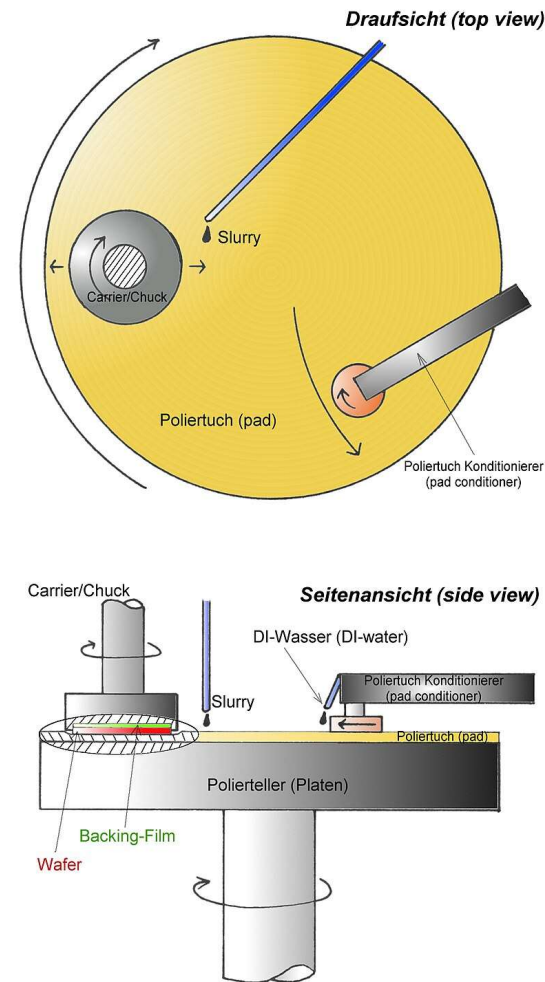


Figure 1: CMP Slurry process (image from Wikipedia)

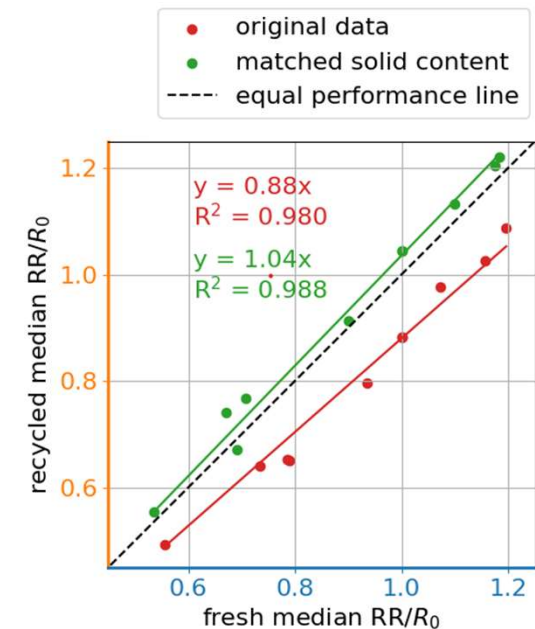


Figure 2: median relative removal rate of fresh slurry (x-axis) vs. recycled slurry (y-axis) (Fraunhofer IPMS measurements)

Further Information

Fraunhofer sustainability



Our contribution to sustainable development

<https://www.fraunhofer.de/en/about-fraunhofer/sustainability.html>

Green ICT



Projectwebsite Green ICT

<https://greenict.de/>

Genesis



Projectwebsite

<https://www.geneseu.eu/>