Sony DADC

Micro Optics

High precision polymer injection molding in Micro Optics

Parma, 11th September 2024

OPTIMAL

Sony DADC - PART OF THE SONY GROUP CORPORATION

SONY

SONY GROUP CORPORATION

Kenichiro Yoshida
CEO

Games & Network Services | Music | Pictures | Entertainment Technology & Services | Imaging & Sensing Solutions | Financial Services | New Initiatives

Sony DADC

Sony DADC GLOBAL

Dietmar Tanzer
President Sony DADC Global

Sony DADC

THALGAU, AT

PILSEN, CZ

TERRE HAUTE, US

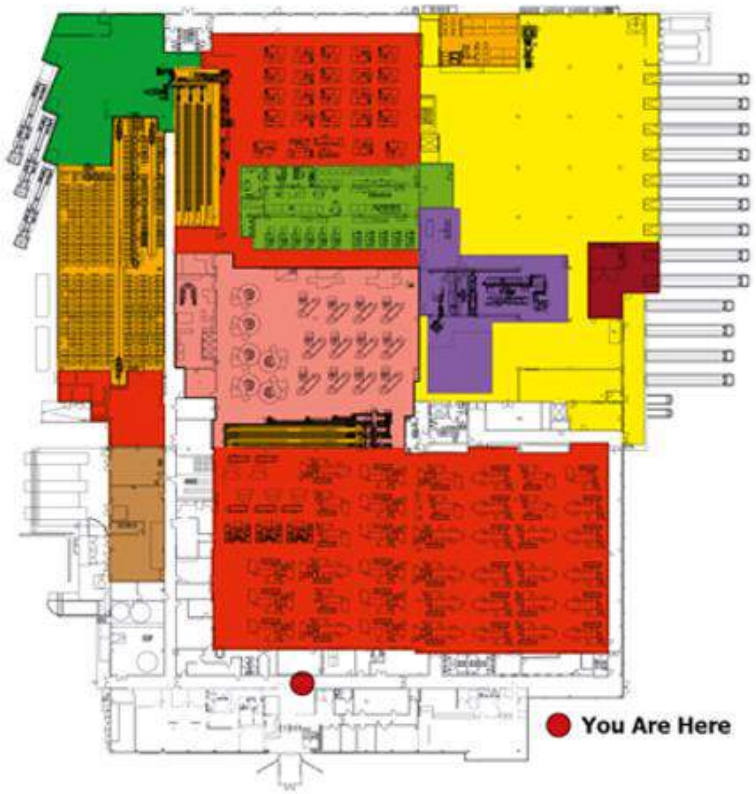
1983
ORGANISATION ESTABLISHED

900
GLOBAL EMPLOYEES

CD, DVD, BD, UHD
CONTRACT MANUFACTURER

26.4 Billion
PRODUCTS IN 40 YEARS

Sony DADC AUSTRIA – THALGAU MANUFACTURING CAMPUS



Area size:	**51,191 sqm**
Building footprint:	**16,062 sqm**
Used floor space:	**41,750 sqm**
Building dimension:	**140 x 115 m**

CLEANROOM ENVIRONMENT

Flexible adaption according to actual demand

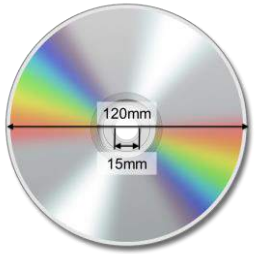
- ISO 6 cleanroom: 500 sqm
- ISO 7 cleanroom: 6,000 sqm
- Useable height: 3 m
- 20 air handling units
- Air exchange rate: 40-80 per hour
- Temperature & humidity controlled
- Exhaust air for different quality fractions

STATE OF THE ART FAB INFRASTRUCTURE - DISC

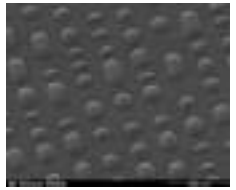
ONE-STOP SHOP SOLUTION

HIGH-PRECISION MICRO AND NANOTECH POLYMER SOLUTIONS

Disc Generations



Disc Shape



PIT length: 150 to 600 nm
PIT depth: 80 nm
PITCH track: 320 nm

MASTER → PLATING → MOLDING → NANO IMPRINT → COATING → BONDING → PACKAGING

ORIGINATION & MASTERING

FLEXIBLE FABRICATION PLATFORM

SUB-MICRON PRECISION

BRIGHT VISIONS

smart solutions!

STATE OF THE ART FAB INFRASTRUCTURE – MICRO OPTICS

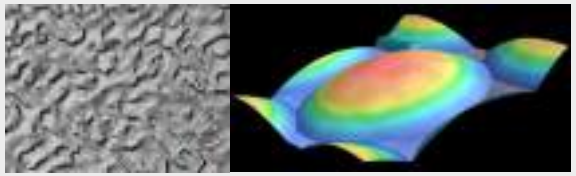
ONE-STOP SHOP SOLUTION

Optical Elements

- ROE - Refractive Optical Elements
- DOE - Diffractive Optical Elements
- MOE - Meta Optical Elements

Wafer Level Optics

Surface structure
50 nm up to 100.000 nm



DESIGN | MASTER | STEP & REPEAT | PLATING | MOLDING | NANO IMPRINT | COATING | ETCHING | BONDING ALIGNMENT | SEPARATION PACKAGING

EXTERNAL | ORIGINATION & MASTERING | FLEXIBLE FABRICATION PLATFORM

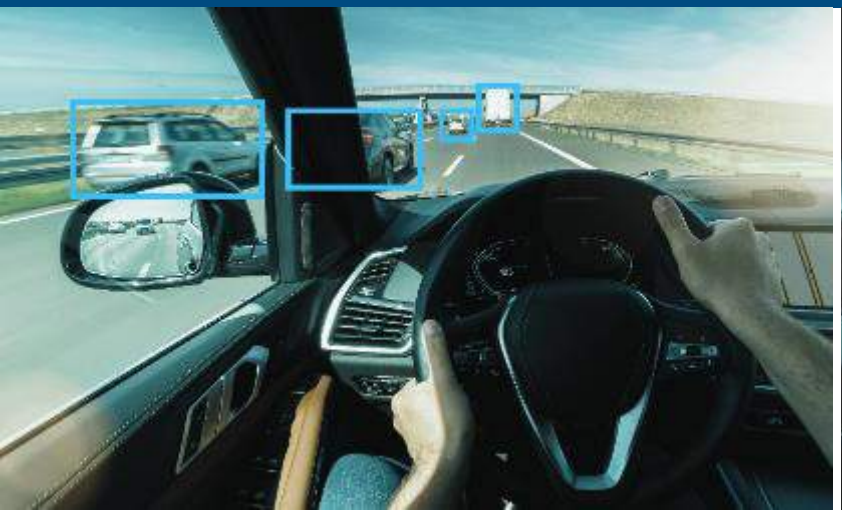
SUB-MICRON PRECISION

BRIGHT VISIONS

smart solutions!

DEVELOP A UNIQUE POLYMER FABRICATION PLATFORM FOR MICRO OPTICS

MADE IN EUROPE



SENSING TECHNOLOGY

LIGHTING SOLUTIONS

CONSUMER ELECTRONICS

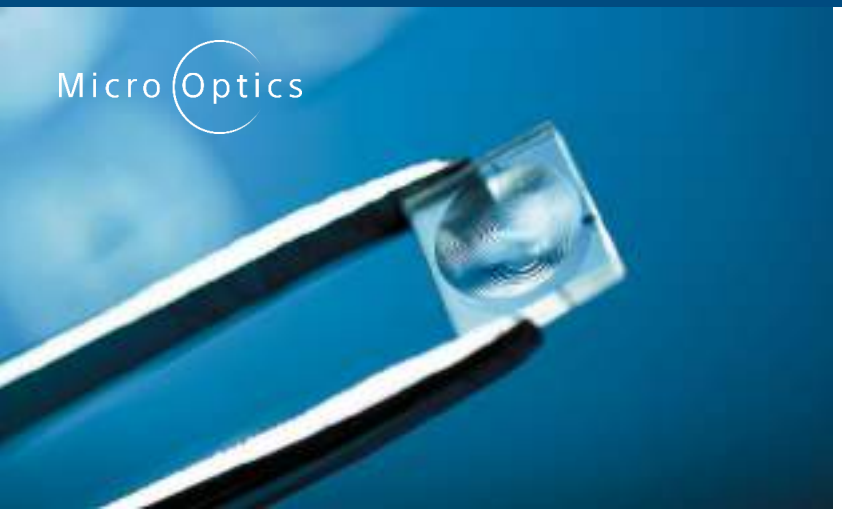
PRIMARY FOCUS

POLYMER SOLUTIONS

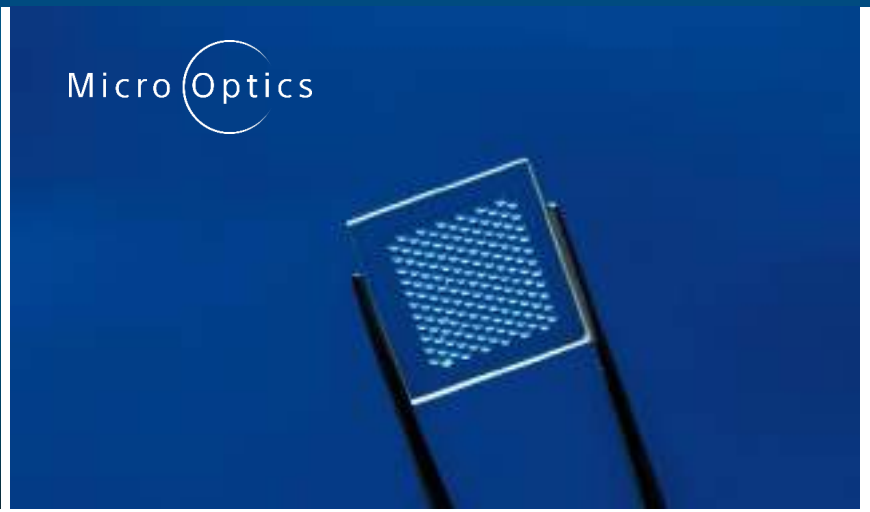
VOLUME FABRICATION

DEVELOPMENT

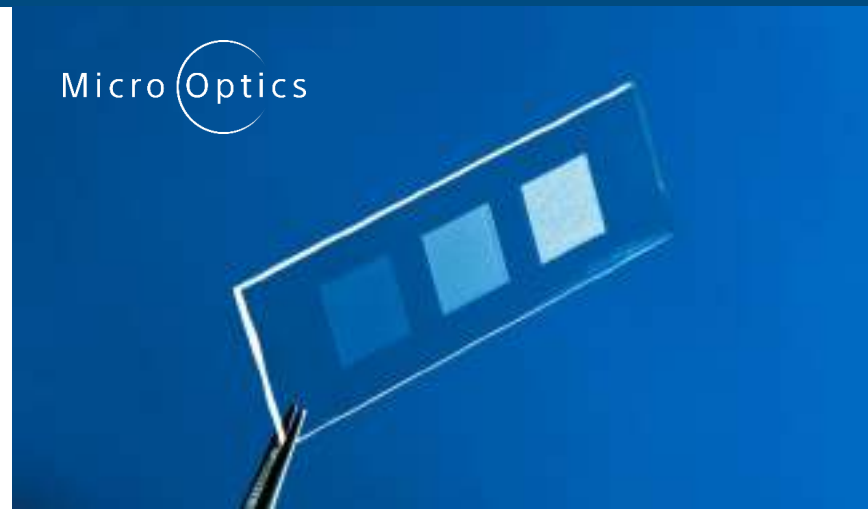
PROTOTYPES IN COOPERATION WITH PARTNERS & RESEARCH INSTITUTES



FRESNEL



MLA



DOE

NEW INITIATIVES

Amongst others we cooperate with:

JOANNEUM RESEARCH

FFG Forschung wirkt.

PROFACTOR®

Horizon Europe

POLYMER OPTICAL PROPERTIES

POLYMER SUBSTRATE

Our various polymers share glass's optical properties

COMPARISON OF POLYMER AND GLASS

- Good thermal-, mechanical-, chemical-, UV resistance
- Same thermal expansion between wafer and lenses
- Lightweight

POLYMER SUBSTRATE PROPERTIES

- Significant cost benefits in high-volume production
- Availability of lower-cost thermoplastic materials
- Robust production capabilities in terms of cycle time and quality

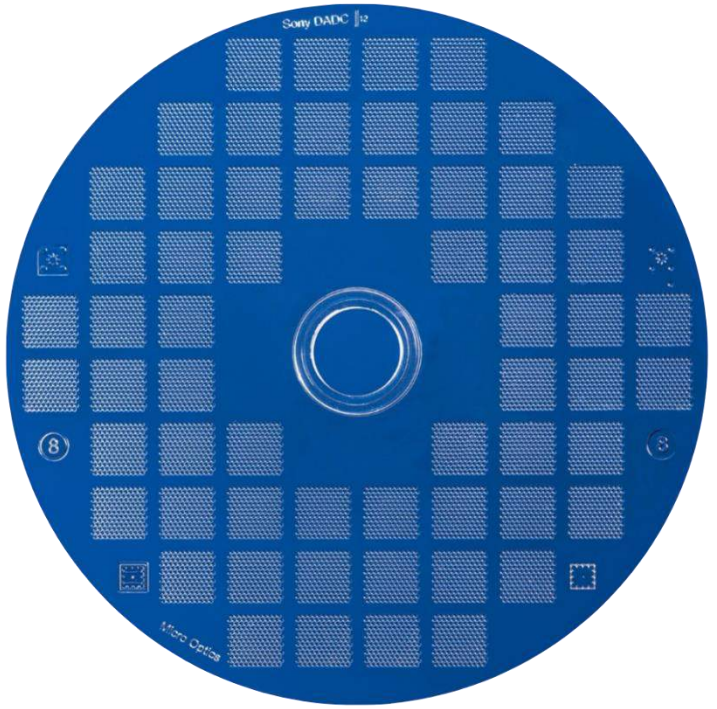
POLYMER INJECTION MOLDING

Hi-speed , Hi-precision optical polymer
Injection molding is a key expertise at Sony DADC

MULTIPLE OPTICAL APPLICATIONS

Micro Optics Polymer Wafer
TTV = 5 µm

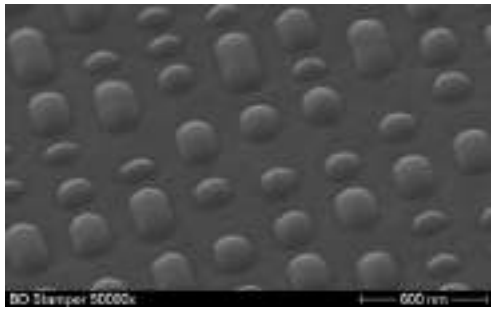
Fully populated wafer with MLA, Fresnel, DOE

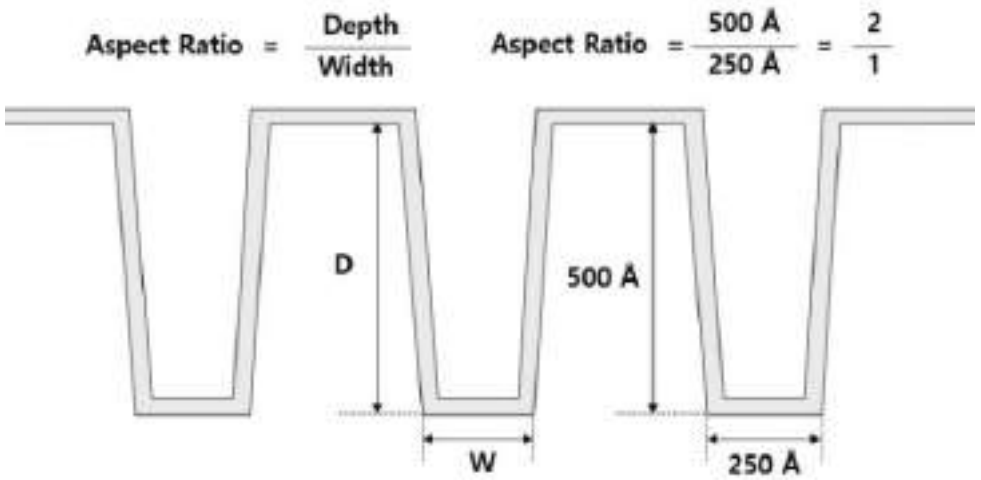


A very good total thickness distribution of our Micro Optics Wafer and various Injection Polymers is the base for multiple optical applications in wafer level optics (ROE, DOE)

NICKEL SHIMS – MECHANICAL SPECIFICATIONS

- **Pure electroformed Nickel**
  - Thickness: 290 +/- 5 µm
  - Inner Diameter: 22 000 +10 / -0 µm
  - Outer Diameter: 138 000 +/- 100 µm
  - Eccentricity: < 10 µm
- **Microstructures**
  - Optical Disc:
    - Pit length: 150 to 600 nm
    - Pit depth: 80 nm
    - Pitch track: 320 nm
  - *Micro Optics / OPTIMAL*
    - *Length: 150 nm – 1000 µm*
    - *Depth: 100 nm – 150 µm*
    - *Aspect Ratio: up to 1:5*
      → important for feasibility estimate





ORIGINATION

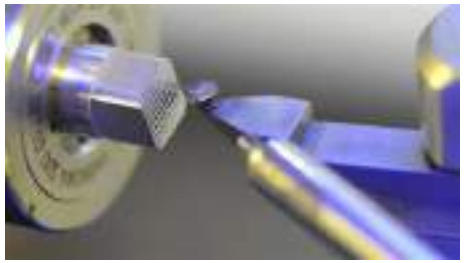
Origination is the process how a substrate with the desired microstructure is made.

Typical ways are:

- Single Point Diamond Turning (brass or NiP)
- Grey-scale Lithography (e.g. mrP-22G_XP, S1818 G2)
- E-Beam Lithography (e.g. PMMA)
- 2-Photon Lithography (e.g. IP-L)

Challenges:

- Sensitive Surfaces:
  - Most of the time no chemical cleaning possible
  - for photoresists:
    Photosensitive (→ hard for QC with microscopes/confocal laser scanning)
- Adhesion of photoresist to substrate
  - especially at edges & corners of microstructures
  - most common issue for electroforming
- Coating with an electroconductive seed layer (Sputtering, ELESS)



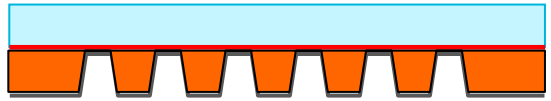
https://i.ytimg.com/vi/aQyG8aOm7yI/maxresdefault.jpg

https://staging.heidelberg-instruments.com/wp-content/uploads/2023/01/CoreTechnology-Header_Grayscale_Fresnel-Vortex-AxiconSEM.webp

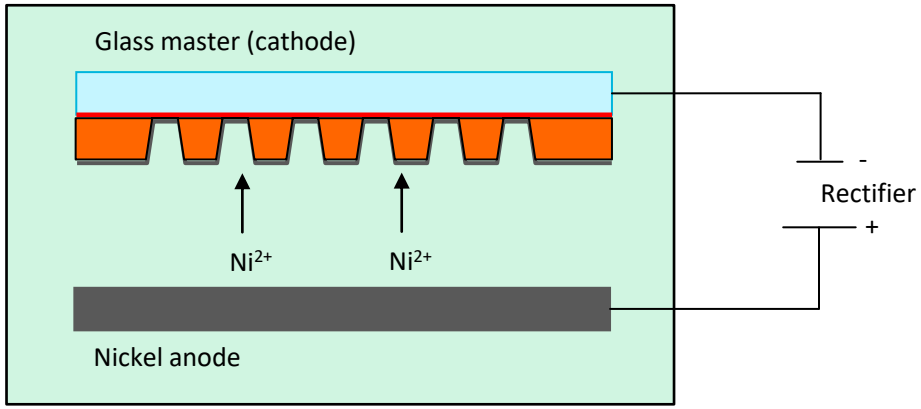
NICKEL ELECTROFORMING

The starting point for Stamper production is a master-substrate with an electroconductive microstructure. The electroconductive coating is mainly done via DC Magnetron Sputtering.
Nickel electroforming describes the process of building up the nickel via electrodeposition onto the master. It is then mechanically separated to produce a nickel product which corresponds precisely to the shape and texture of the original substrate. Parts of the photoresist will remain on the nickel surface and are removed with sodium hydroxide and ozone treatment. The final mechanical tolerances are achieved via backside polishing and shaping of the nickel shim.

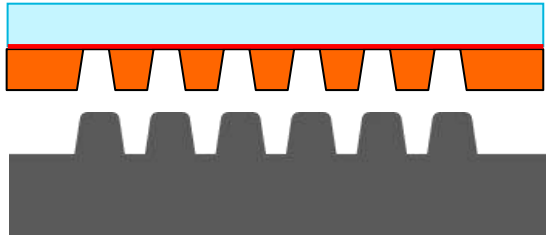
GLASS MASTER WITH ELECTROCONDUCTIVE SURFACE



ELECTRODEPOSITION PROCESS



SEPARATION OF MASTER AND STAMPER



NICKEL ELECTROLYTE & PLATING PARAMETERS

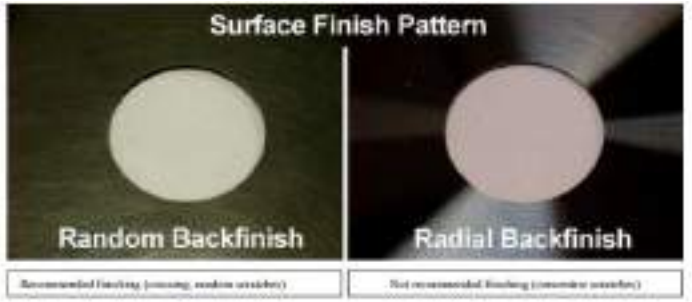
- Typical electrolyte (Dischem. Inc)
  → Microsoft Word - EFMP2908 CHEMISTRY AND RELATIONSHIPS IN SN BATHS.D (dischemInc.com)

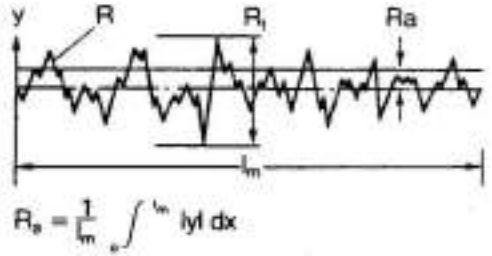
Anode Material	Nickel Metal (g/L)	Boric Acid (g/L)	Temp. (°C)	Surface Tension (dynes/cm) {%/vol. E-liminate Pit}	Internal Stress of Deposit	Anode Corroder (g/L as chloride)
Use only sulfur depolarized nickel	76 – 105	Saturation by temperature	45 – 60	28 – 32 {0.2 – 0.4}	0 – 4000 PSI Tensile	1.5 – 3.0

- Common Issues:
  - Filtration (1 µm, 99% efficiency)
  - Temperature Stability (sufficient cooling)
  - Break-down products of additives
    - keep it simple (no additives, only boric acid & halogenide anode corroder)
    - use high purity chemicals & DI Water (10 MΩcm, 0.1 µm filtered)

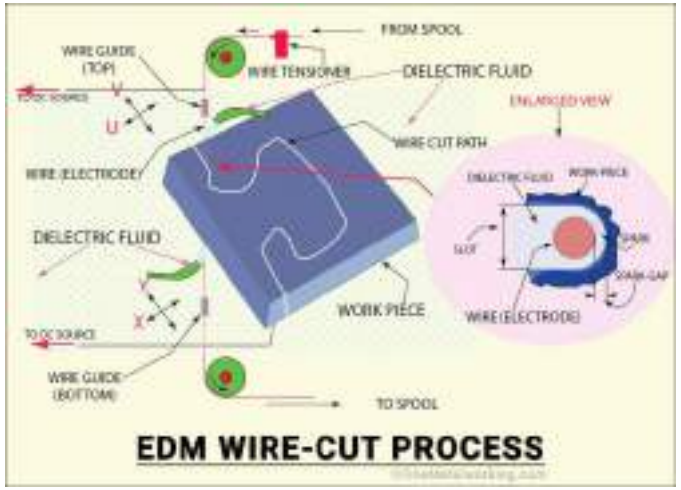
BACKSIDE POLISHING & SHAPING

- Wet backside Polishing (Siebert Technologies Ltd.)
  - Optical Disc: Ra 0.04 – 0.15 µm
  - OPTIMAL: undefined



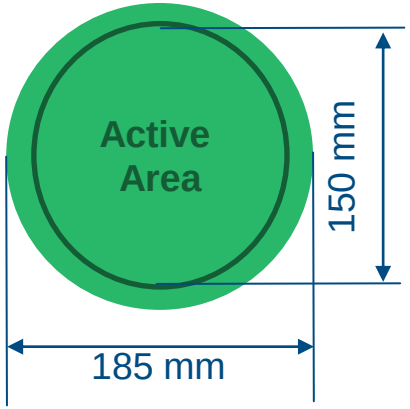


- Shaping:
  - Mechanical Punching
  - Wire-Cutting
  - Machining

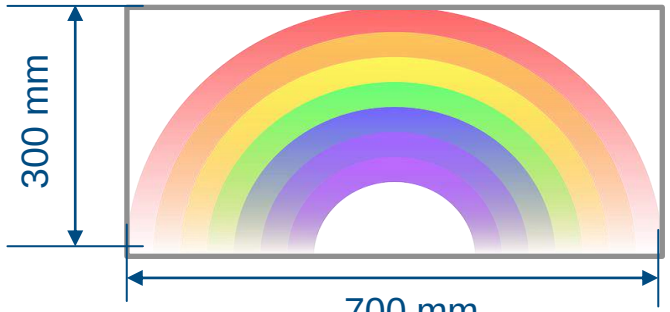


NICKEL ELECTROFORMING FOR PROJECT OPTIMAL

> Upscaling of our process to substrate sizes 70 x 30 cm²
>> surface increase by Factor 7!

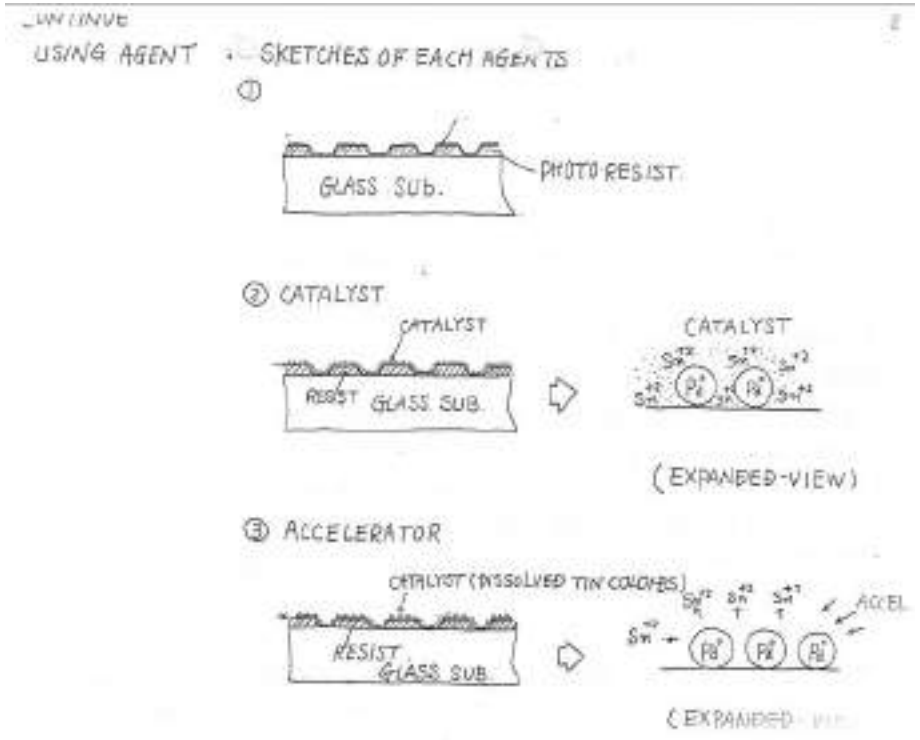


x7



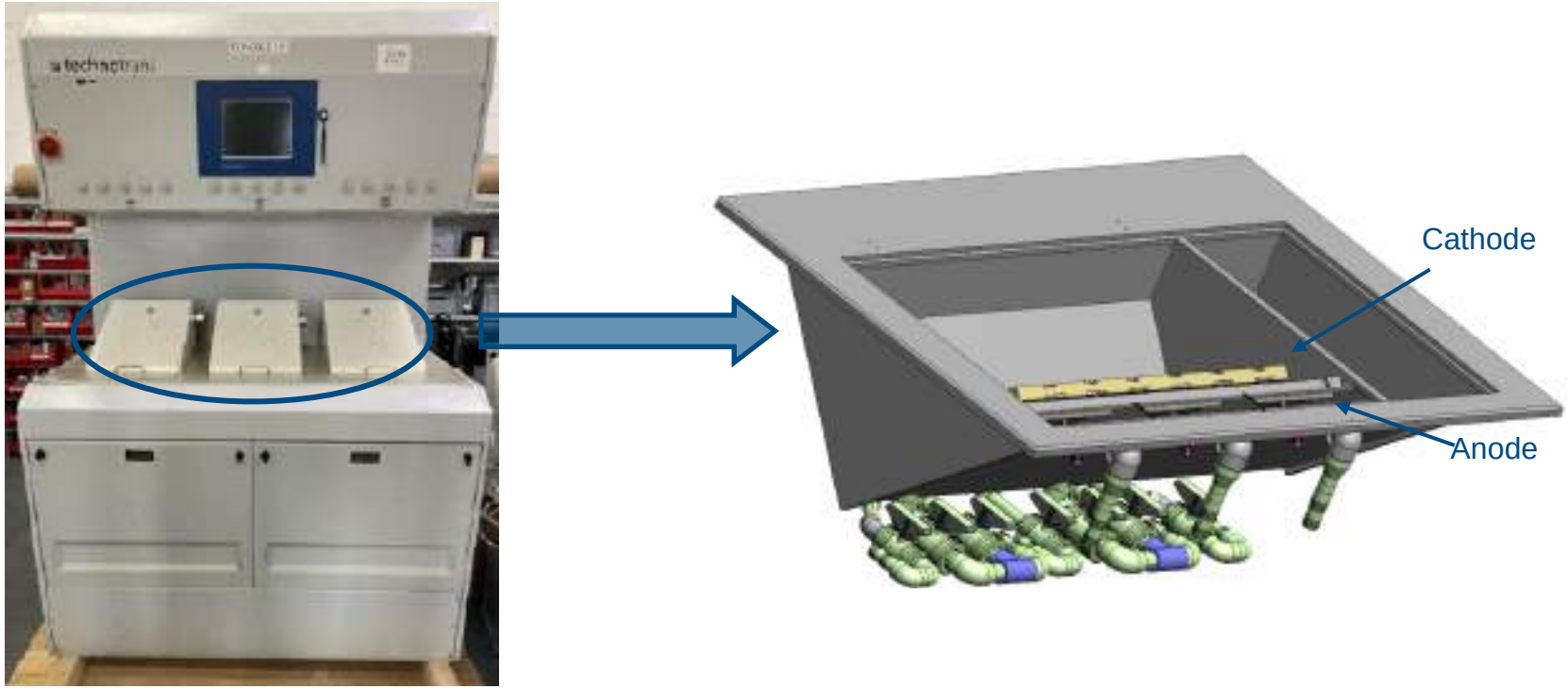
NICKEL ELECTROFORMING FOR PROJECT OPTIMAL

- Upscaling of our process to substrate sizes 70 x 30 cm²
  - surface increase by Factor 7!
  - need for large-scale seed layer process & electroforming equipment
- Max. wafer size for DC Magnetron Sputtering @Sony DADC
- Going back to the roots of Optical Disc Mastering:
  Electroless Nickelplating (ELESS) from 1990



NICKEL ELECTROFORMING FOR PROJECT OPTIMAL

- Upscaling of our process to substrate sizes 70 x 30 cm²
  - Modification of electroforming equipment: 3 baths to 1 bath



Sony DADC AS PARTNER TO ENHANCE MICRO OPTICS TECHNOLOGY IN POLYMER

WE OFFER

POLYMER SOLUTIONS INSTEAD OF EXISTING GLASS SOLUTIONS
PROTOTYPING & MASS FABRICATION MADE IN EUROPE
DEVELOPMENT & PROCESS ENGINEERING TEAM

WE ARE ON THE LOOKOUT

TECHNOLOGY EXCHANGE (PROCESSES, MATERIAL, METROLOGY, …)
TECHNICAL SPECIFICATIONS FOR USE CASES IN PRIMARY MARKET SEGMENTS
PARTNERS FOR DEVELOPMENT PROJECTS AND MASS PRODUCTION IN POLYMER

Sony DADC

Micro Optics

Thank you!

Paul Weitnauer
Mastering Engineering Manager
paul.weitnauer@sonydadc.com