

**MediaTech Showcase & Conference  
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**Production of 3rd generation  
recordable discs,  
especially HD-DVD/R  
and an industrial solution for that**



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A MEMBER OF THE SINGULUS GROUP



- \* Differences between DVD/R and HD-DVD/R
- \* HD-DVD/R structure
- \* What is necessary to produce high quality HD-DVD/R ?
- \* What are the critical values at a HD-DVD/R ?
- \* What are the differences within the production equipment ?



**Many customers get confused with statements like:**

**‘All DVD/R production lines can do 16x DVD/R’**

**‘All DVD/R production lines can do HD-DVD/R’**

# Format Comparison DVDR – HD-DVDR:



(Overall Disc Differences)

	DVDR	HD DVDR
Data capacity per layer	<b>4.7 GB</b>	<b>15 GB</b>
Wavelength	650 nm	405 nm
Numerical Aperture	0.60	0.65
Spot size	0.54 $\mu\text{m}$	0.31 $\mu\text{m}$
Track pitch	0.74 $\mu\text{m}$	0.4 $\mu\text{m}$
Length of shortest pit	0,4 $\mu\text{m}$	0.2 $\mu\text{m}$
Reference scanning velocity	3.49 m/s	6.61 m/s
Reference channel bit rate	26 Mbps	65 Mbps

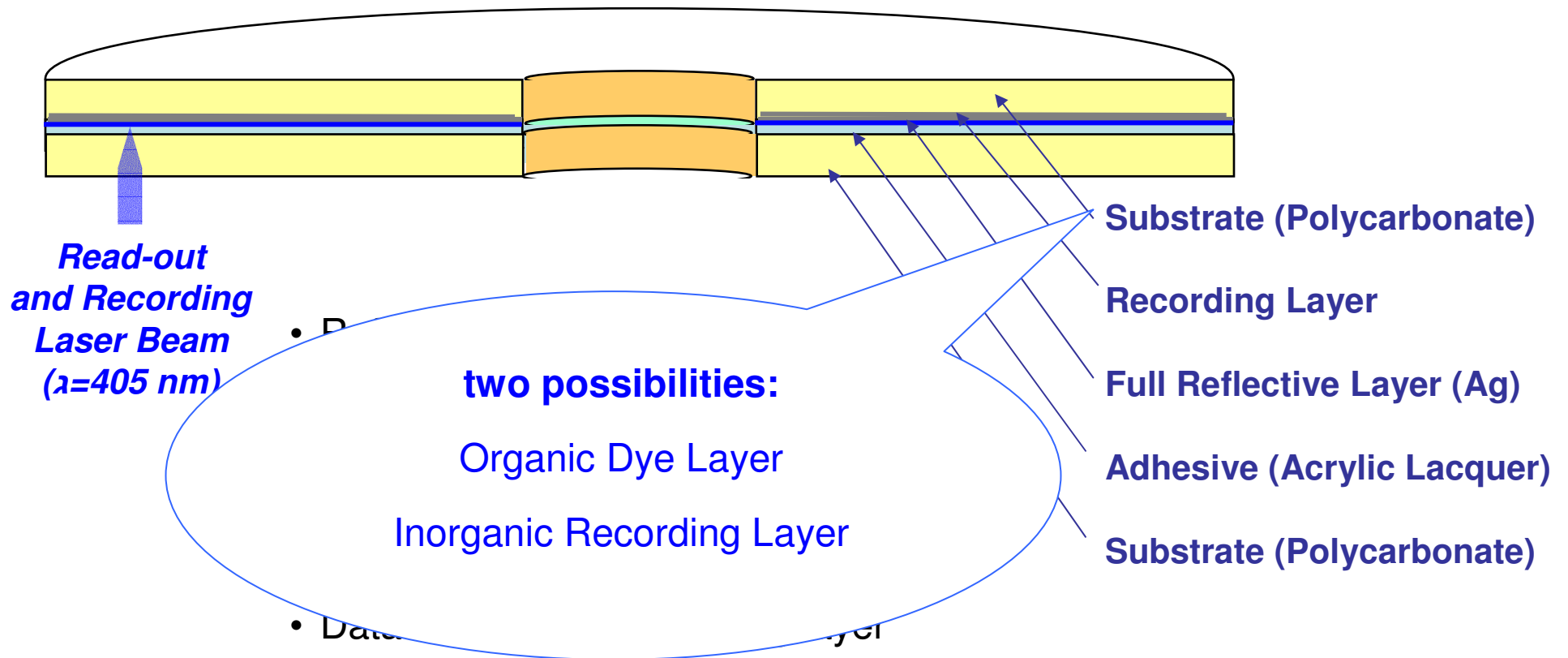
# Format Comparison DVDR – HD-DVDR:



(Mechanical Properties)

	DVDR	HD DVDR
Cover layer	600 $\mu\text{m} \pm 30 \mu\text{m}$	600 $\mu\text{m} \pm 13 \mu\text{m}$
Spacer layer	55 $\mu\text{m} \pm 15 \mu\text{m}$	20 $\mu\text{m} \pm 5 \mu\text{m}$
Variation spacer layer on a disc	$\pm 10 \mu\text{m}$	$\pm 5 \mu\text{m}$
Variation spacer layer one revolution	$\pm 5 \mu\text{m}$	$\pm 2 \mu\text{m}$
Radial Deviation	$\pm 0,7^\circ$	$\pm 0,7^\circ$
Tangential Deviation	$\pm 0,3^\circ$	$\pm 0,2^\circ$
Birefringence	60 nm	60 nm

# Layout of a HD-DVD-Recordable



# Necessary changes for HD-DVD/R production



	<b>HD DVDR Specification</b>	<b>HD DVDR Production</b>
<b>Cover layer</b>	<b>600 <math>\mu\text{m}</math> <math>\pm</math> 13 <math>\mu\text{m}</math></b>	<b>600<math>\mu\text{m}</math> <math>\pm</math> 6<math>\mu\text{m}</math></b>
<b>Spacer layer</b>	<b>20 <math>\mu\text{m}</math> <math>\pm</math> 5 <math>\mu\text{m}</math></b>	<b>Less</b>
<b>Variation spacer layer on a disc</b>	<b><math>\pm</math> 5 <math>\mu\text{m}</math></b>	<b>Less</b>
<b>Variation spacer layer one revolution</b>	<b><math>\pm</math> 2 <math>\mu\text{m}</math></b>	<b>Less</b>
<b>Radial Deviation</b>	<b><math>\pm</math> 0,7°</b>	<b><math>\pm</math> 0,5°</b>
<b>Tangential Deviation</b>	<b><math>\pm</math> 0,2°</b>	<b><math>\pm</math> 0,15°</b>
<b>Birefringence</b>	<b>60 nm</b>	<b>Less</b>

**Birefringence is more important than some people think and expect !!**

## Important machine steps for HD-DVD/R



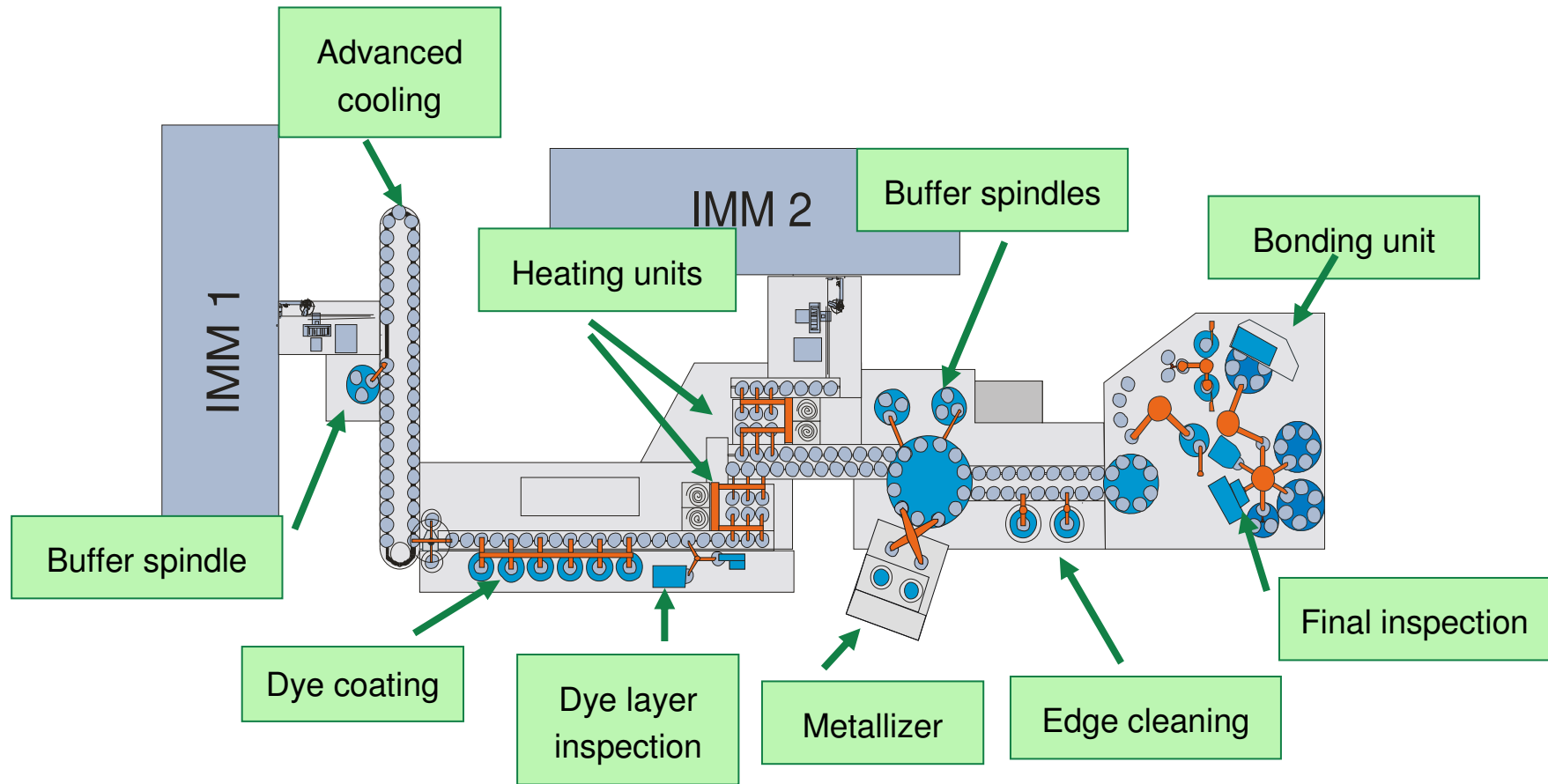
- Injection Molding Machine
- Mold
- Cooling before dye coating
- Dye Coating
- Metall Layer / Sputtering
- Bonding
- Groove replication & Tilt
- Groove, Disc uniformity
- Tilt & Uniformity
- OD-Layer
- Metall Layer Uniformity
- Bonding Layer Uniformity

## Important machine steps for HD-DVD/R



- What is necessary from the HW side to allow such tight tolerances ?
- What kind of control systems does the equipment need to offer ?

# TAURUS DVD/R line



# Controlled substrate cooling



## Challenges:

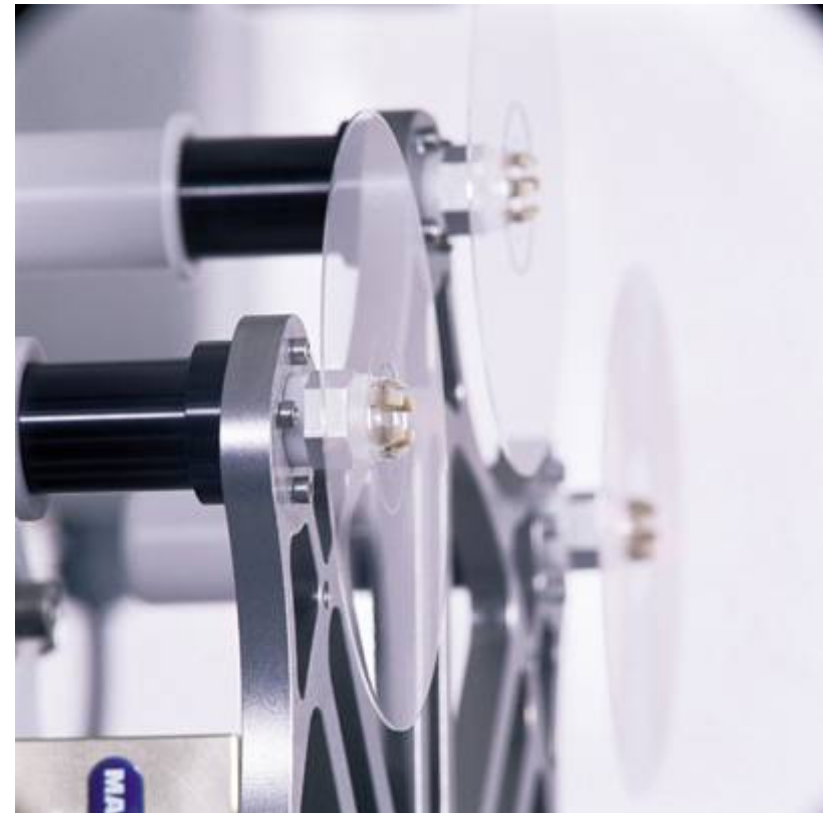
- Uniform disc cooling
- Avoiding tilt variability

## HamaTech Solution:

- Pre-stabilizer (8Pos) holds the discs without any external forces
- Smooth free-convection cooling

## Advantages:

- Fast disc stabilization
- No influence of cooling on tilt
- Very fast molding speeds possible



# Substrate conditioning



## Challenges:

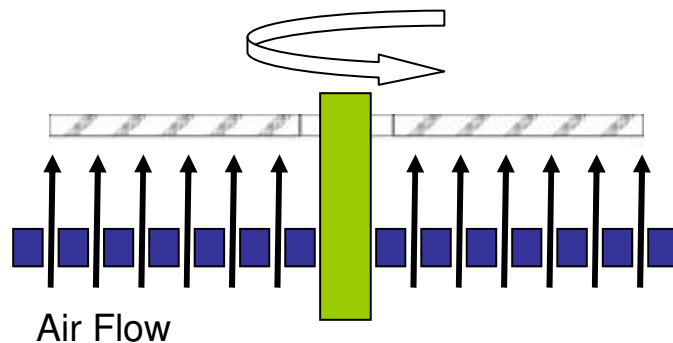
- Substrate conditioning prior to dye coating

## HamaTech Solution: **new**

- Air cushion balanced transport conveyor
- Effective and homogeneous air-flow cooling

## Process Advantages:

- Substrates have consistent tilt, leading to stable further process conditions
- Reduced material

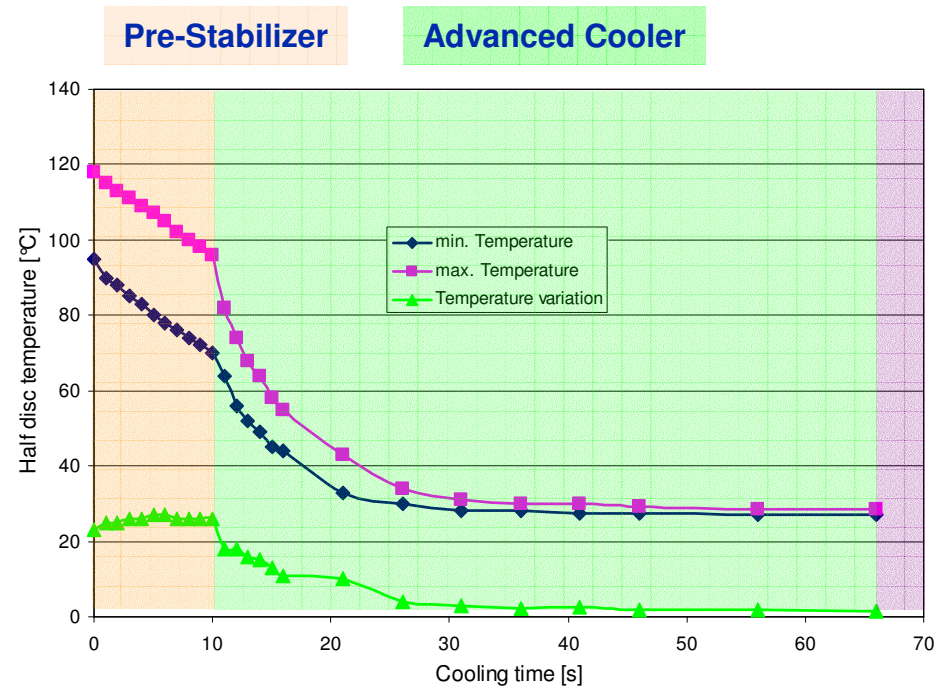


# Substrate cooling overview

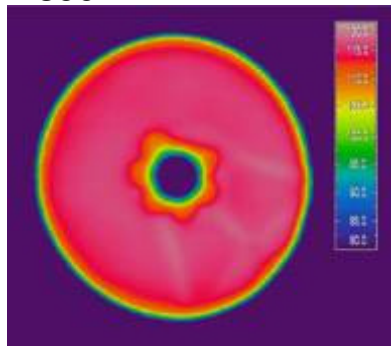


## Advantages:

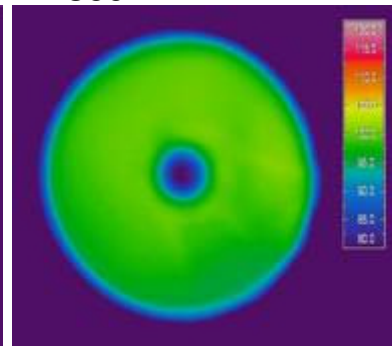
- Extremely homogeneous and effective substrate cooling
- Forceless cooling
- Thoroughly conditioned substrates before dye coating (even at 2 sec cycle time)



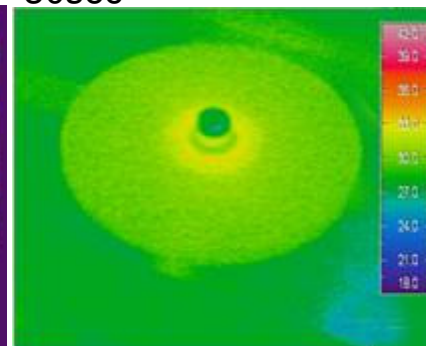
2sec



12sec



30sec



# Dye Coating - Dispense



## Challenge:

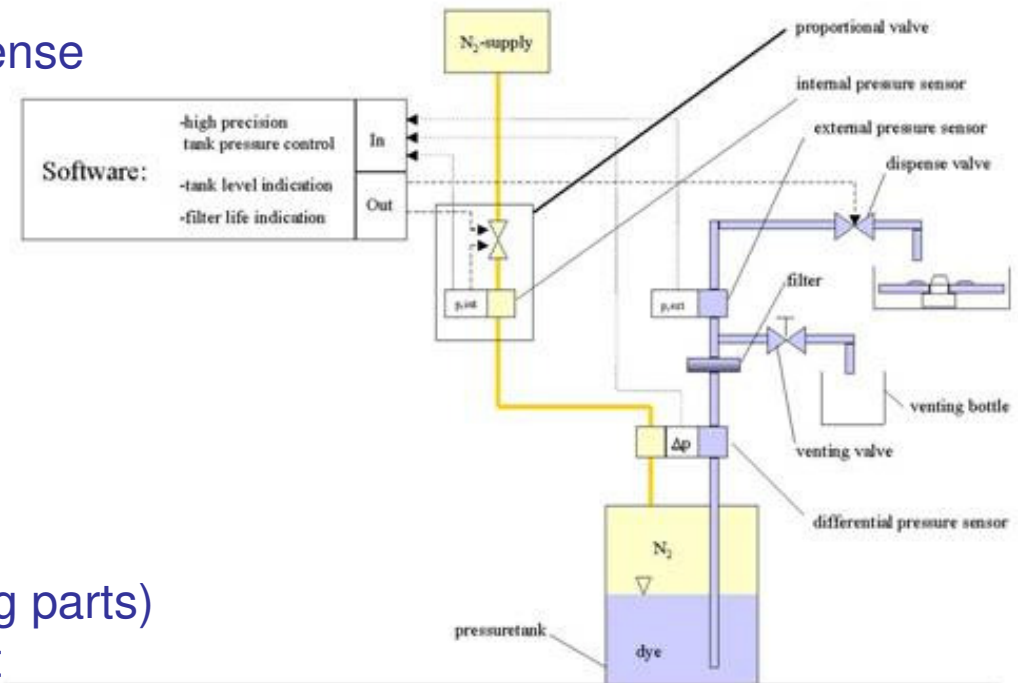
- Highly accurate and constant dye dispense

## HamaTech Solution:

- Media system with pressurized tanks

## Process Advantages:

- High dispense precision
- Highly reproducible dye volume  
(minimum reproducible volume: 20  $\mu\text{l}$ ,  
typical dye dispense volume: 85  $\mu\text{l}$ )
- No dye pump (no dye contact of moving parts)
- Absolutely particle free media transport
- No dye crystallization within media system
- Improved dye yield



# Closed-Loop Dye Process Control



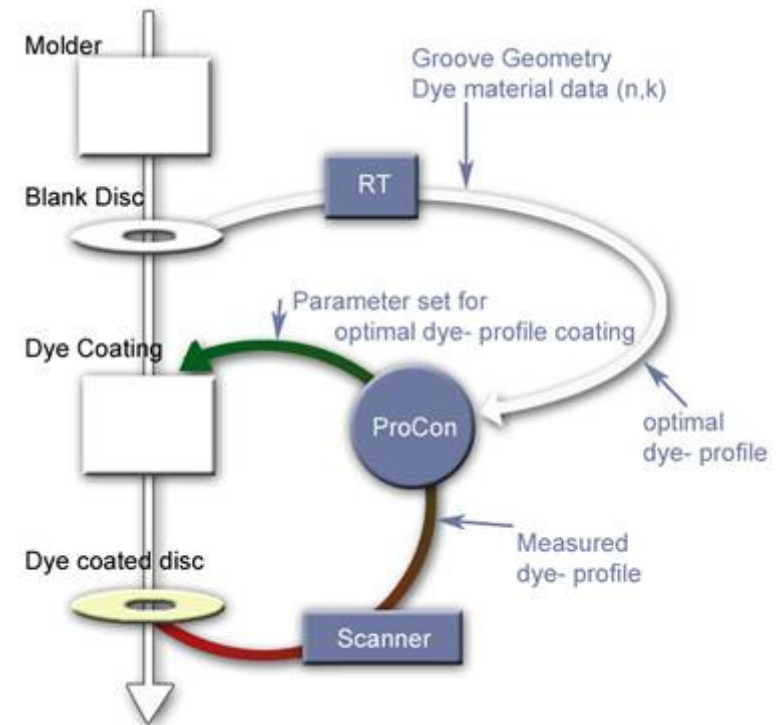
## Challenges:

- Compensation of unavoidable environmental changes to dye layer properties
- Precise control of radial dye layer profile
- Operator-free optimization

## HamaTech Solution:

Closed-loop process control based on:

- In-line measurement of each disc
- Dye cup specific measurement analysis
- Automated comparison with desired dye profile
- Optimization of 4 dye coating parameters to reduce dye profile deviations



# Drying / Heating

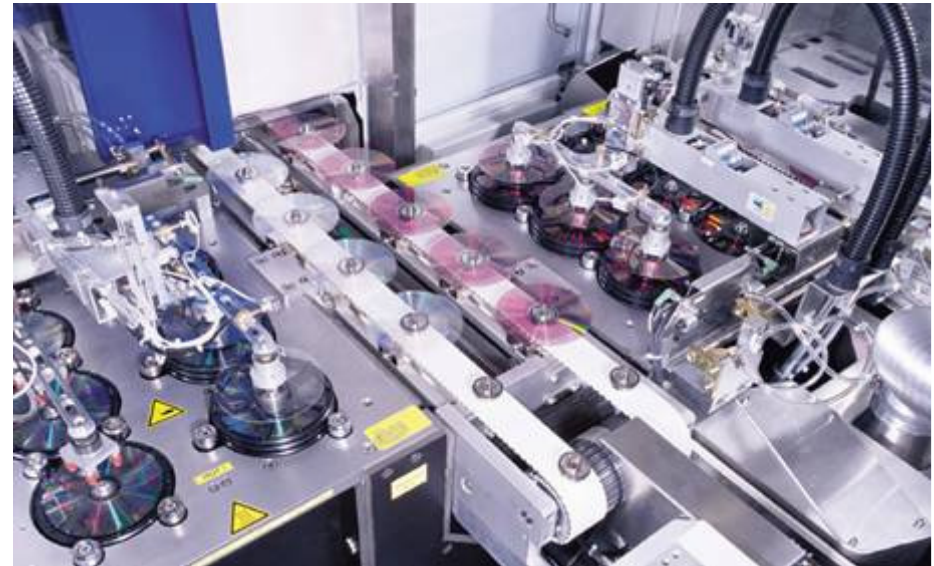


## Challenges:

- Complete evaporation of the dye solvent
- Capable for different dye technologies

## HamaTech Solution:

- Two compact stack dryers with horizontally stored discs (142 each stack)
- Constant hot airflow (up to 100°C set-point), while discs are rotating



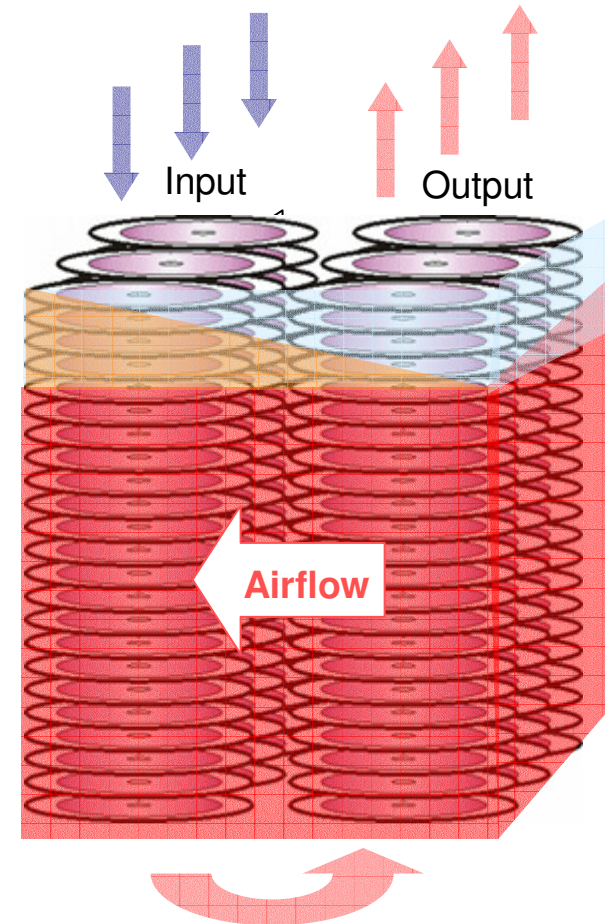
## Process Advantages :

- Very homogeneous temperature distribution on the disc
- First in-first out principle for constant drying/heating times
- Same treatment conditions for active and dummy disc
- Separate drying/heating units for active and dummy disc
- Capable for different dye technologies

# Drying / Heating - Principle



- Homogeneous temperature distribution over each disc due to vertical air-flow
- No temperature shock for half discs when entering/leaving the dryer



# Metallizers for DVD/R application



## The Challenge:

- Small footprint combined with good access to all components

## HamaTech Solution:

- Accessible arranged components completely integrated
- Stainless steel base frame concept – running on rails
- Main chamber top plate is removable without dismounting of cathodes

## Advantage:

- Higher uptime by easy access for maintenance
- No additional cabinet space needed



**Dual Cathode Metallizer**

# Sputtering - Inline Thickness Control (ITC)



## Challenge:

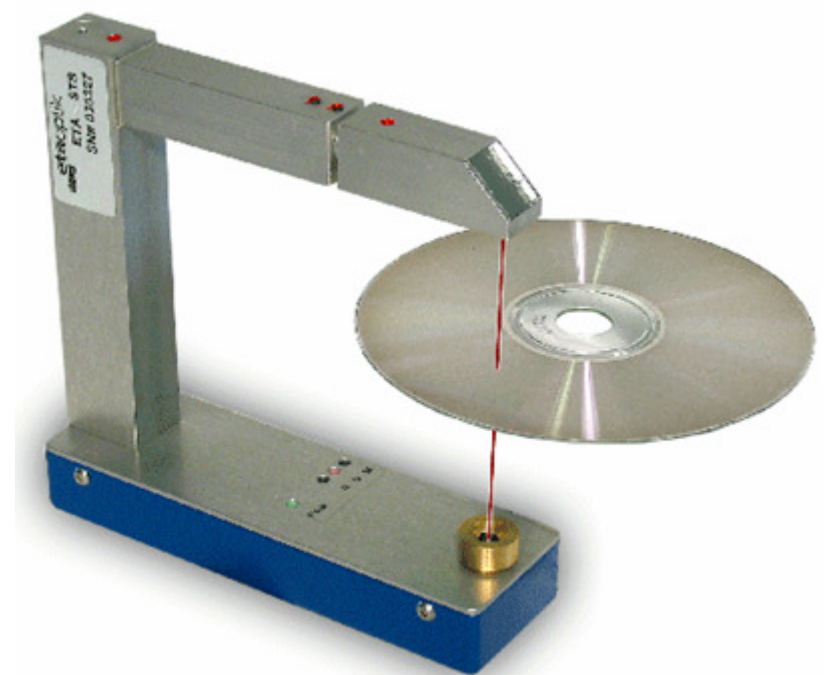
- Uniform sputtering with lowest required layer thickness for optimal target utilization

## HamaTech Solution:

- Inline sputter thickness sensor (STS) designed by STEAG ETA-Optik
- Closed-loop thickness control of sputter layer

## Process Advantages:

- Continuous measurement of layer thickness distribution
- Controlled layer uniformity
- Optimized target utilization



# Bonding Station



## The Challenge:

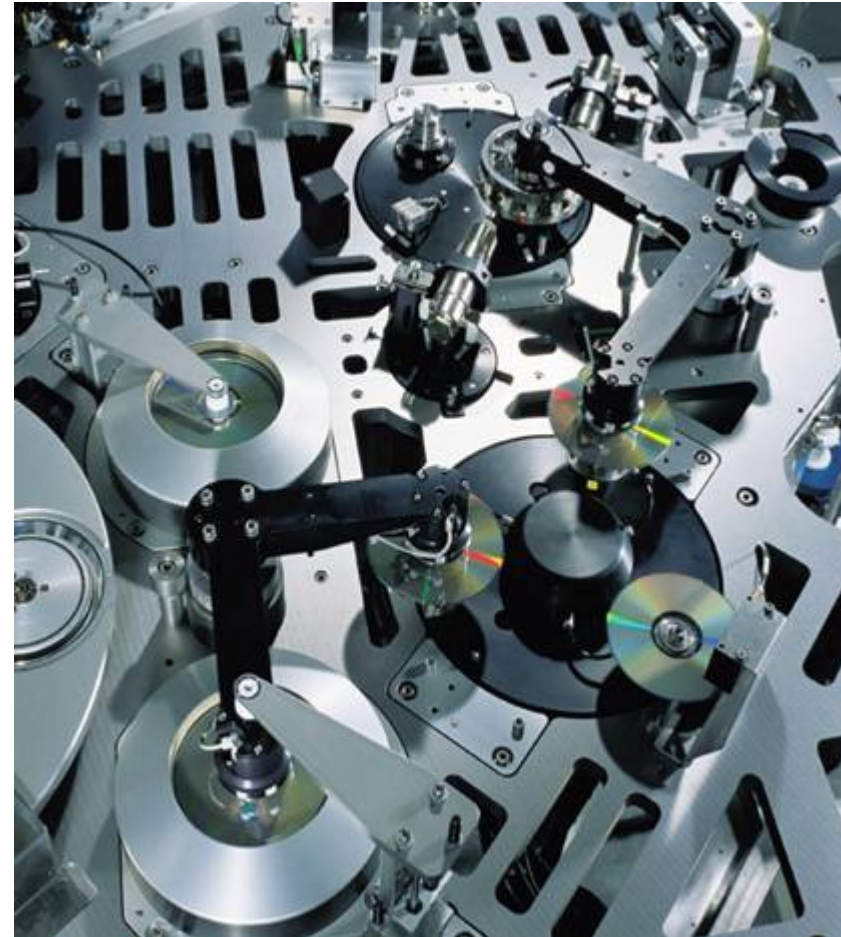
- Consistent bonding conditions even with unstable clean room environment
- Adhesive application and disc bonding without bubbles

## HamaTech Solution:

- Adhesive temperature control system
- Dual Dispense Bonding
- Fast loading logistic

## Advantage:

- Consistent adhesive viscosity
- Consistent quality even with outside temperature changes
- Fast cycle times
- Higher yield → high output



# Spacer Layer Uniformity



## Challenge:

- Adhesive layer uniformity near the center of the disc

## HamaTech Solution:

- Intermediate turn table (3 disc positions), after dispense before spinout to distribute adhesive evenly driven by natural capillary forces

## Advantages:

- Reduced variation of layer thickness
- Small defects near the center hole are eliminated
- Enlarged bonding process window
- HD-DVD layer thickness will be reached



# Spacer Layer Uniformity



## Challenge:

- Adhesive layer uniformity near the center of the disc

## HamaTech Solution:

- Spin cup with vacuum suction in the center position avoids entering of air into the ID during spin-off

## Advantages:

- Reduced variation of layer thickness
- Small defects near the center hole are eliminated
- Enlarged bonding process window
- HD-DVD/R layer thickness will be reached



# Tilt Control



## Challenge:

- Possibility to reduce dependency on tilt of halfdiscs

## HamaTech Solution:

- Patented Vortex-Cooling System (based on cooling of upper halfdisc)

## Advantage:

- Possibility to control radial deviation



# Adhesive Curing



## Challenge:

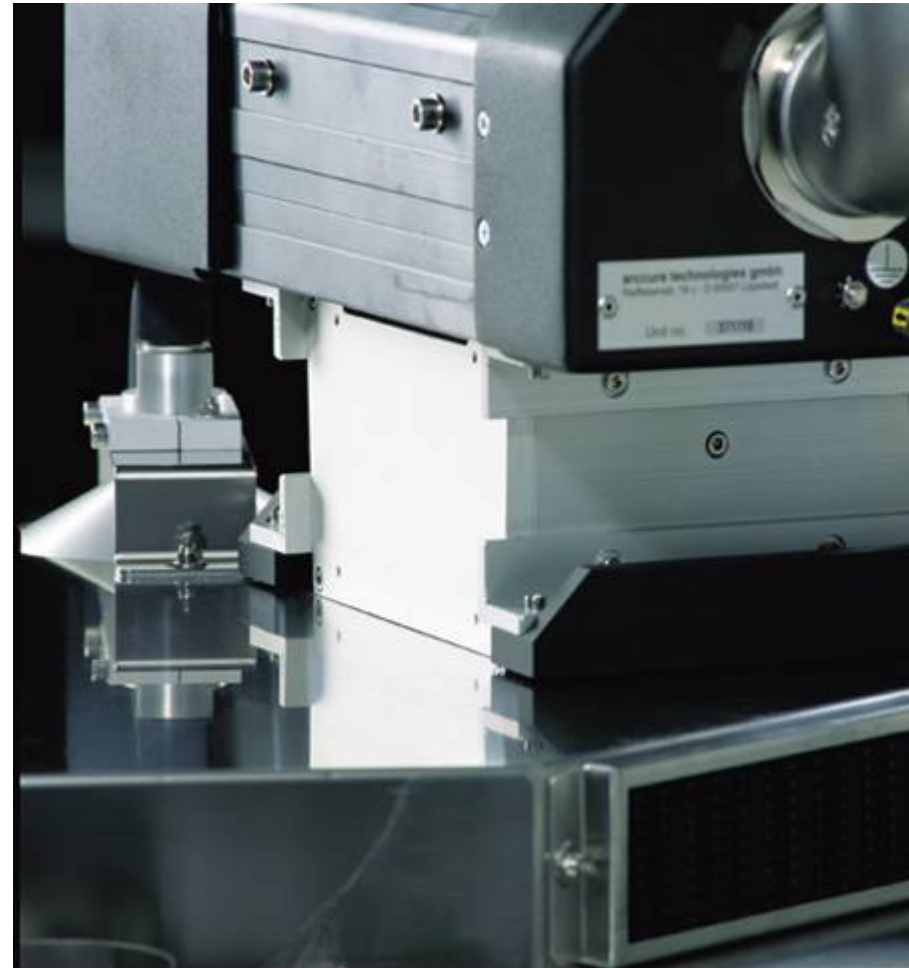
- Complete and uniform adhesive curing with low heat generation

## HamaTech Solution:

- Special UV lamp provides selective spectral filtering to minimize heat input to discs

## Advantages:

- Adhesive is cured with less total energy
- Reduced heat and tilt
- Short cycle times





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**Thank you !!**

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