

# UV Curing Process for UV Powder

Kevin Joesel

Fusion UV Systems, Inc

[www.fusionuv.com](http://www.fusionuv.com)

# Presentation Format

- Obligatory Company Commercial
- UV Curing Principles
- UV Processing Challenges
- UV Powder Application Examples

# Fusion UV Systems, Inc.



- International Headquarters Gaithersburg, MD
- The Preferred Provider of UV curing systems and technology, world-wide
  - Microwave-Powered lamp systems and technology
  - Custom engineered systems

# Our Strengths . . . Summary



- Customer applications and advanced process knowledge
- Industry's most advanced and broadest range of microwave powered and arc-based UV illumination systems design & optimization
- Customer service
- Quality and reliability
- UV curing industry involvement
- Global presence - maximum support

# Serving Global Industrial and Scientific Communities

## Worldwide Locations



### North America:

- **Corporate Headquarters**  
**Fusion UV Systems, Inc.**  
Gaithersburg, Maryland
- **Fusion UV Systems West**  
Torrance, California

### Europe:

- **Fusion UV Systems GmbH**  
Martinsried, Germany  
Kolarovo, Slovakia
- Poland
- France
- Spain
- Italy
- Scandinavia
- Israel
- United Kingdom

### Asia Pacific:

- **Fusion UV Systems Japan KK**  
Tokyo, Japan
- **Fusion UV Systems**  
Singapore
- **Fusion UV Systems**  
Beijing, China  
Guangzhou, China  
Shanghai, China

- Indonesia
- Korea
- Malaysia
- Philippines
- Taiwan
- Thailand
- Australia
- India
- New Zealand

### Latin America:

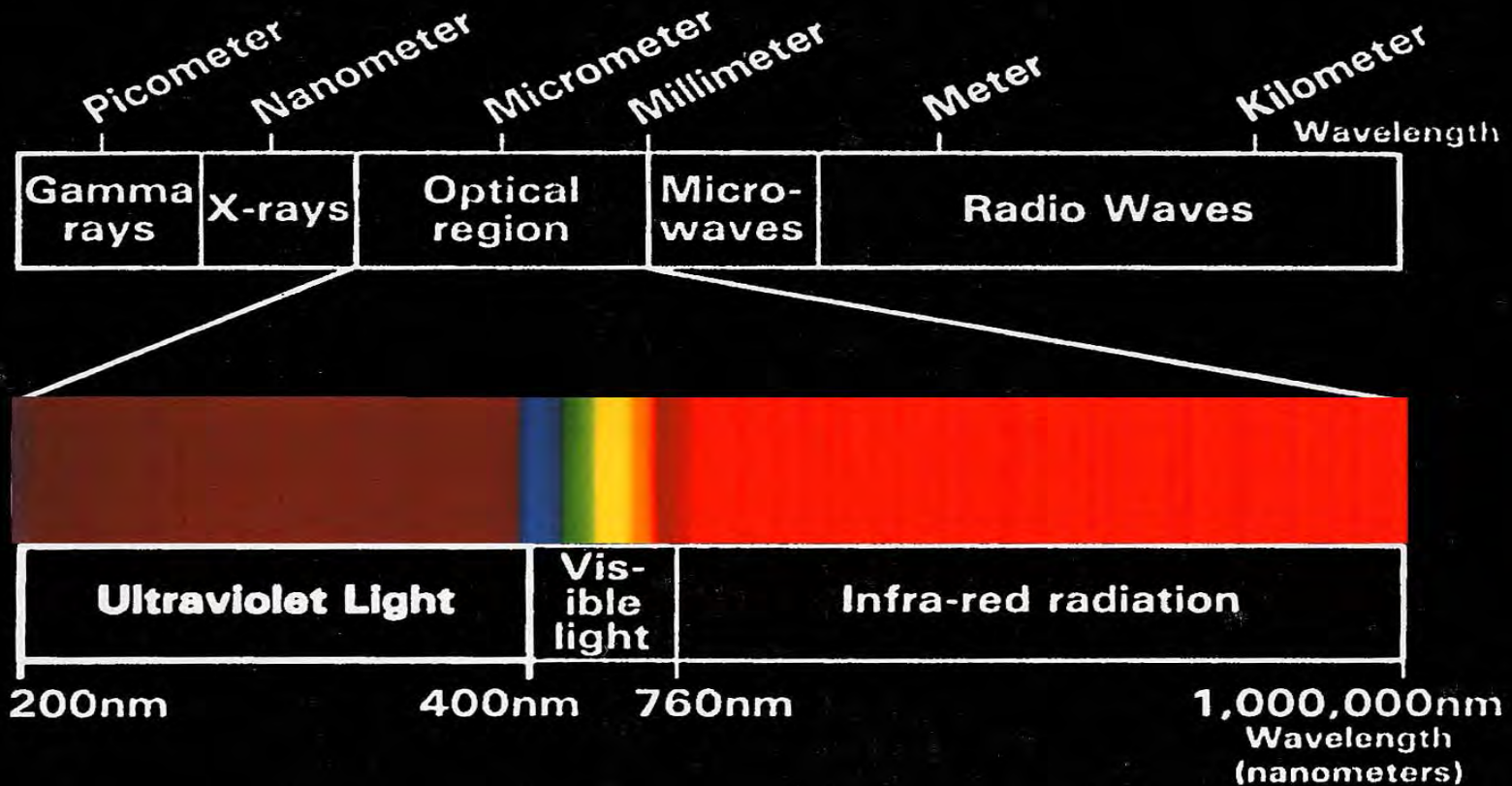
- Argentina
- Brazil
- Chile
- Colombia
- Costa Rica
- Mexico
- Puerto Rico
- Venezuela





# Standard Products

# Optimize Spectral Output for Maximum Process Performance



# UV Curing Principles

## Factors Affecting Cure

- Irradiance                      UV Power                      ex. (watts/cm<sup>2</sup>)
- Exposure Time    (Irradiance x time = joules/cm<sup>2</sup>)
- UV Spectral Output Distribution
- UV Spectral Absorbion of the Coating
- Infrared Energy may need to be minimized



# Key Elements of UV Curing Equipment

- UV Energy  $\text{J}/\text{cm}^2$ 
  - total energy arriving at the coating surface
  - inversely proportional to speed
- UV Irradiance  $\text{W}/\text{cm}^2$ 
  - intensity of the light at the coating surface
  - characteristic of the lamp & geometry of the reflector
  - independent of speed
- Spectral output of the bulb
  - wavelength distribution

# UV Energy

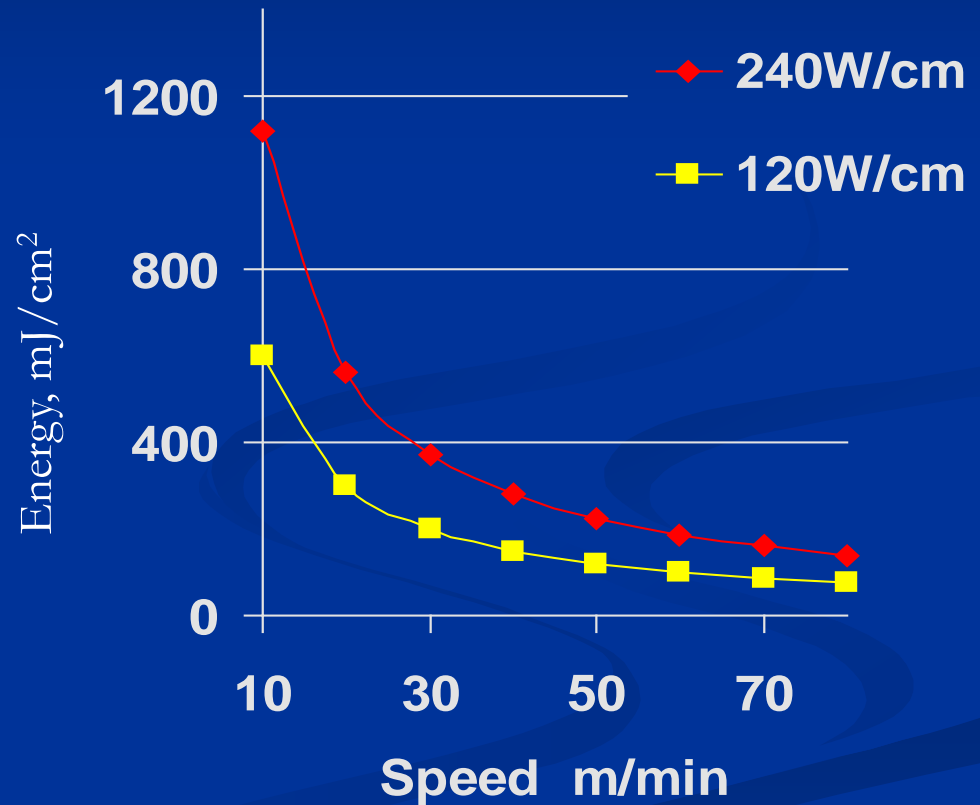
Energy is inversely proportional to:-

→ **line speed**

and directly proportional to :-

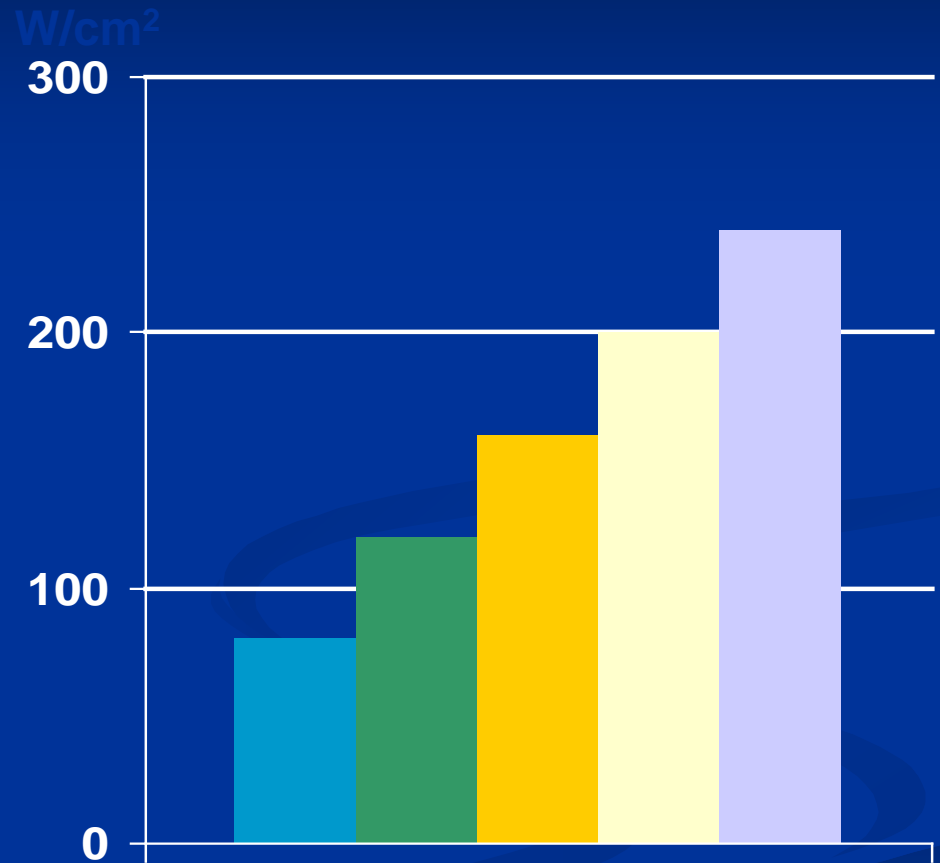
→ **lamp power**

→ **number of lamps**

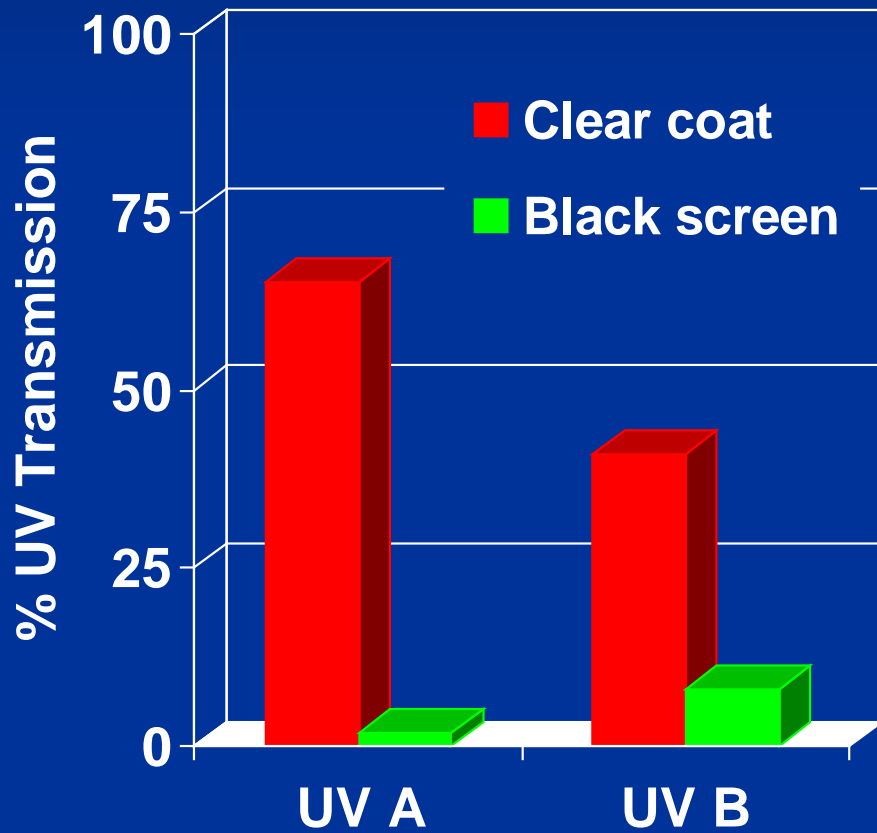


# Lamp Power $\text{W}/\text{cm}^2$

- ◆ Allows general comparison of lamps
- ◆ No information about intensity
- ◆ No information about spectral distribution



# Competition for UV Light



- Absorption of UV varies with wavelength
- Good transmission through clear coat.
- Poor transmission through black ink
- Pigments compete with PI for UV light
- match pigment, PI and bulb spectra

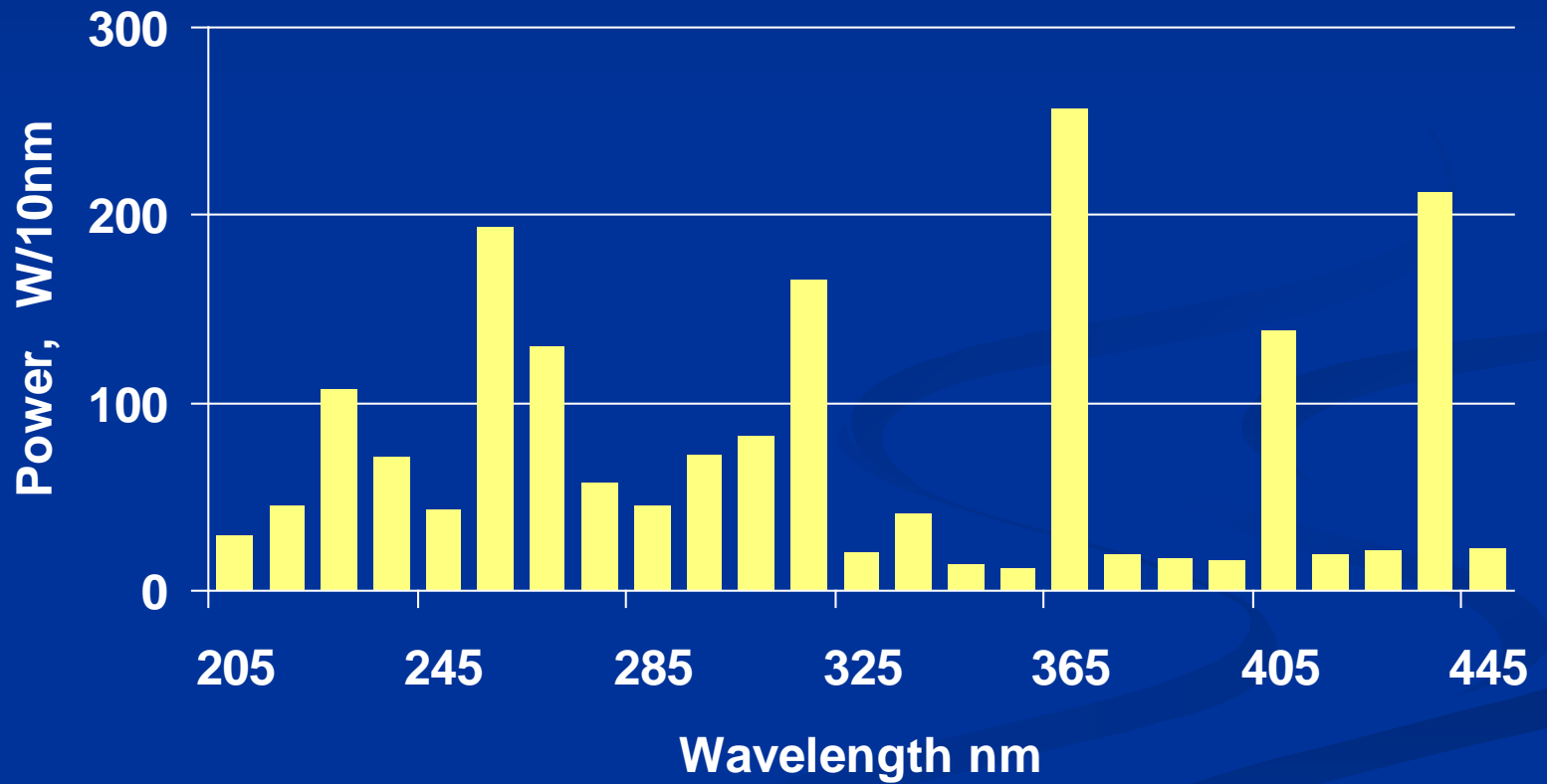


# Variety of Bulbs

Allows the UV output from the bulb to match the absorption profile of the photoinitiator

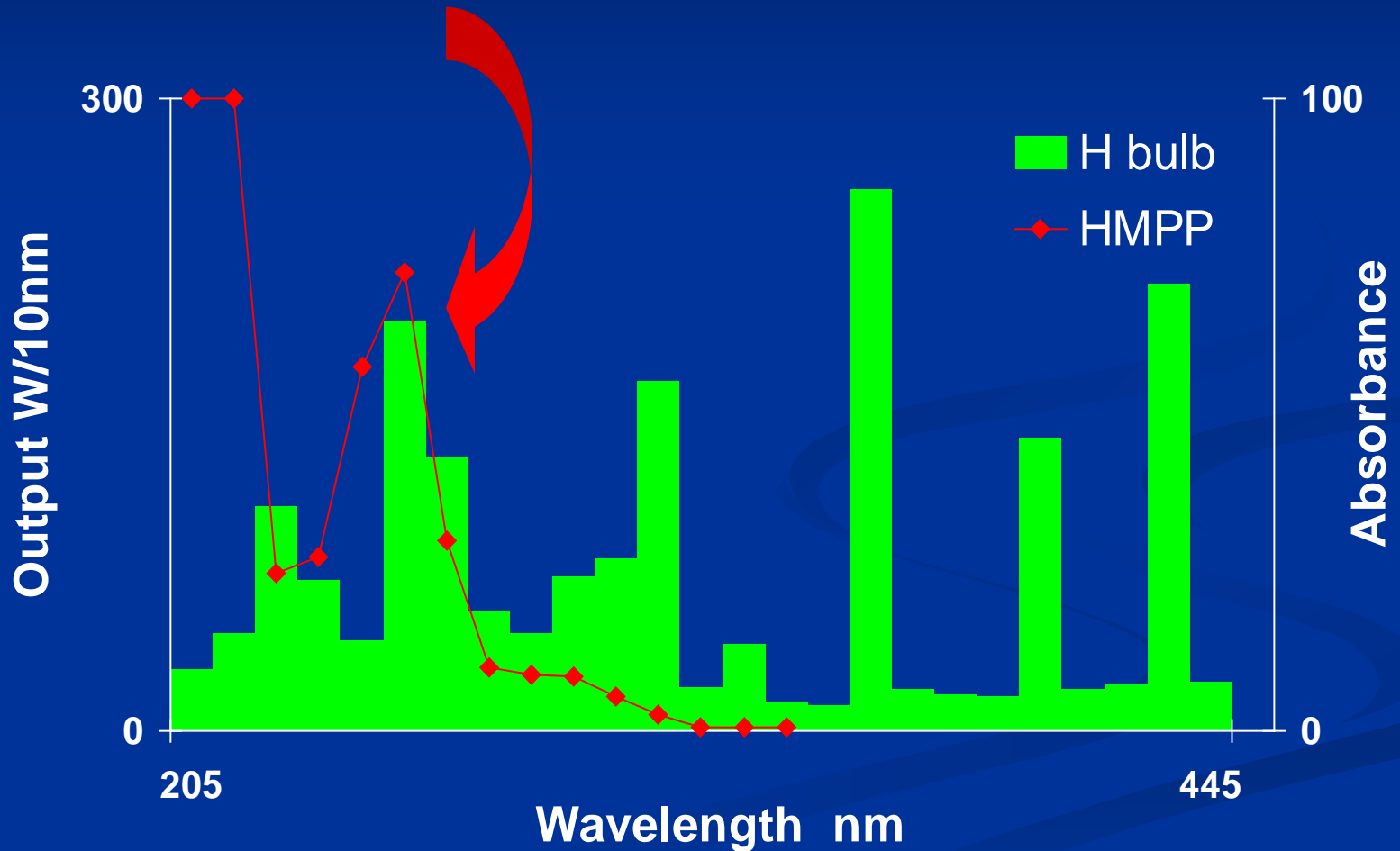
- efficient use of UV energy and photoinitiator
- important in pigmented systems, where pigment competes for UV energy
- demanded by coatings containing packages of photostabilisers & photoinitiators
- longer wavelength (350-400nm) allows better penetration of UV energy through thick coatings

# H Bulb

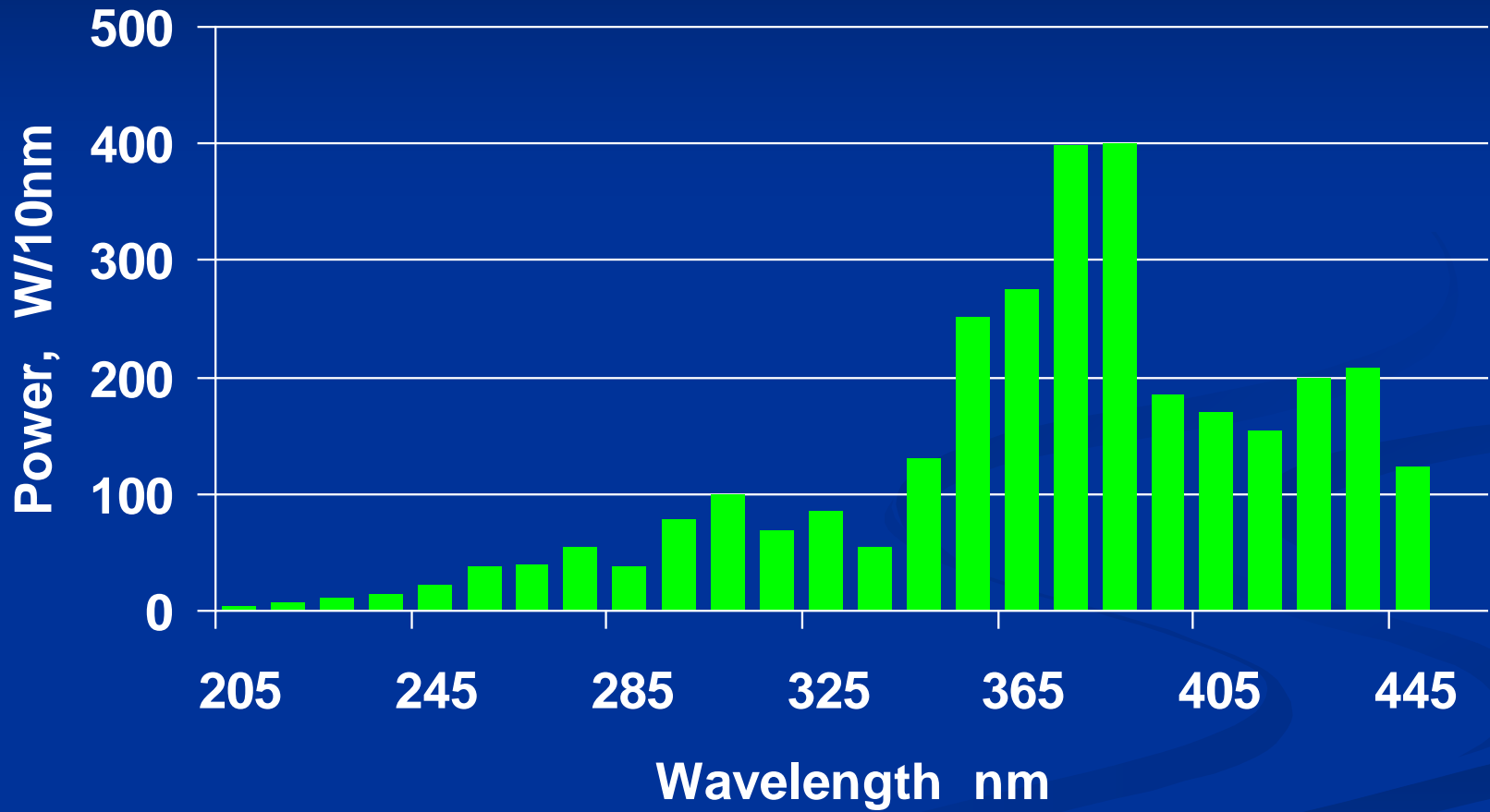


# H Bulb

Overlap of bulb spectra & photoinitiator



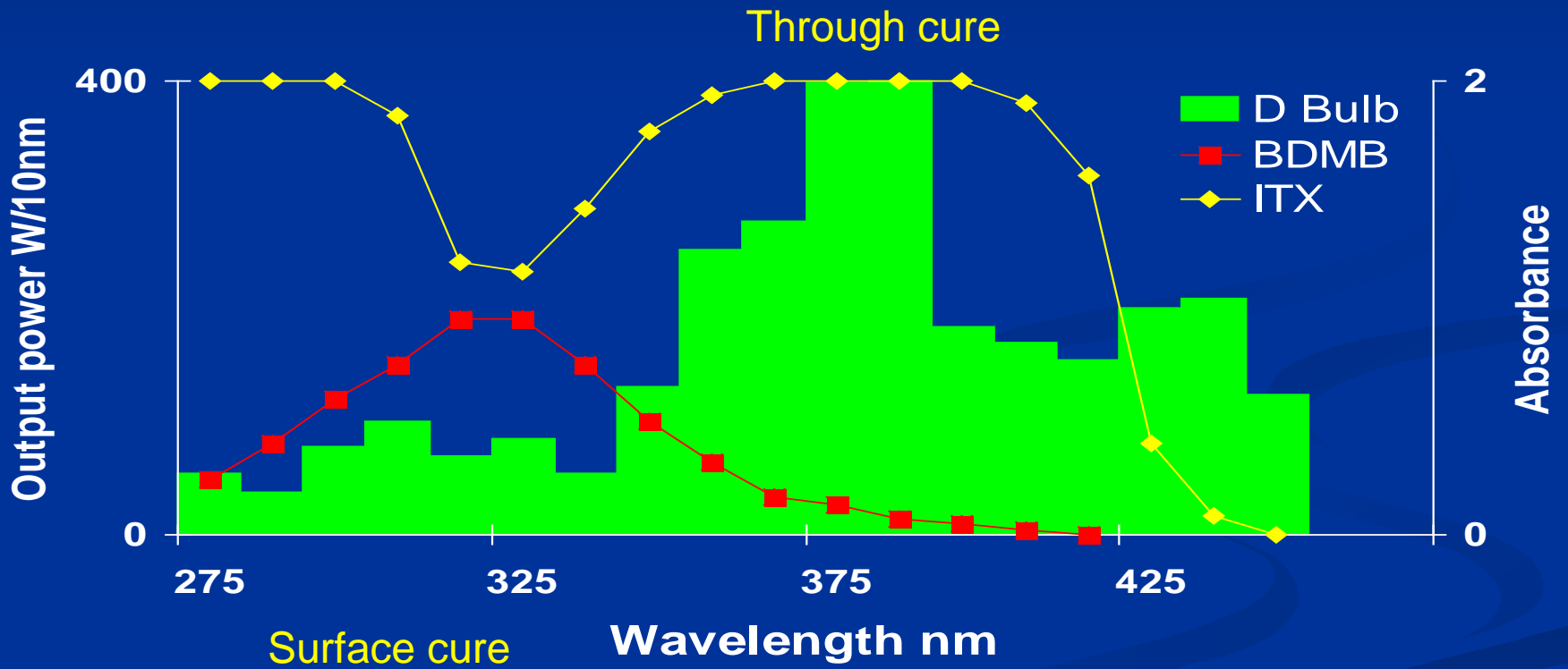
# D Bulb



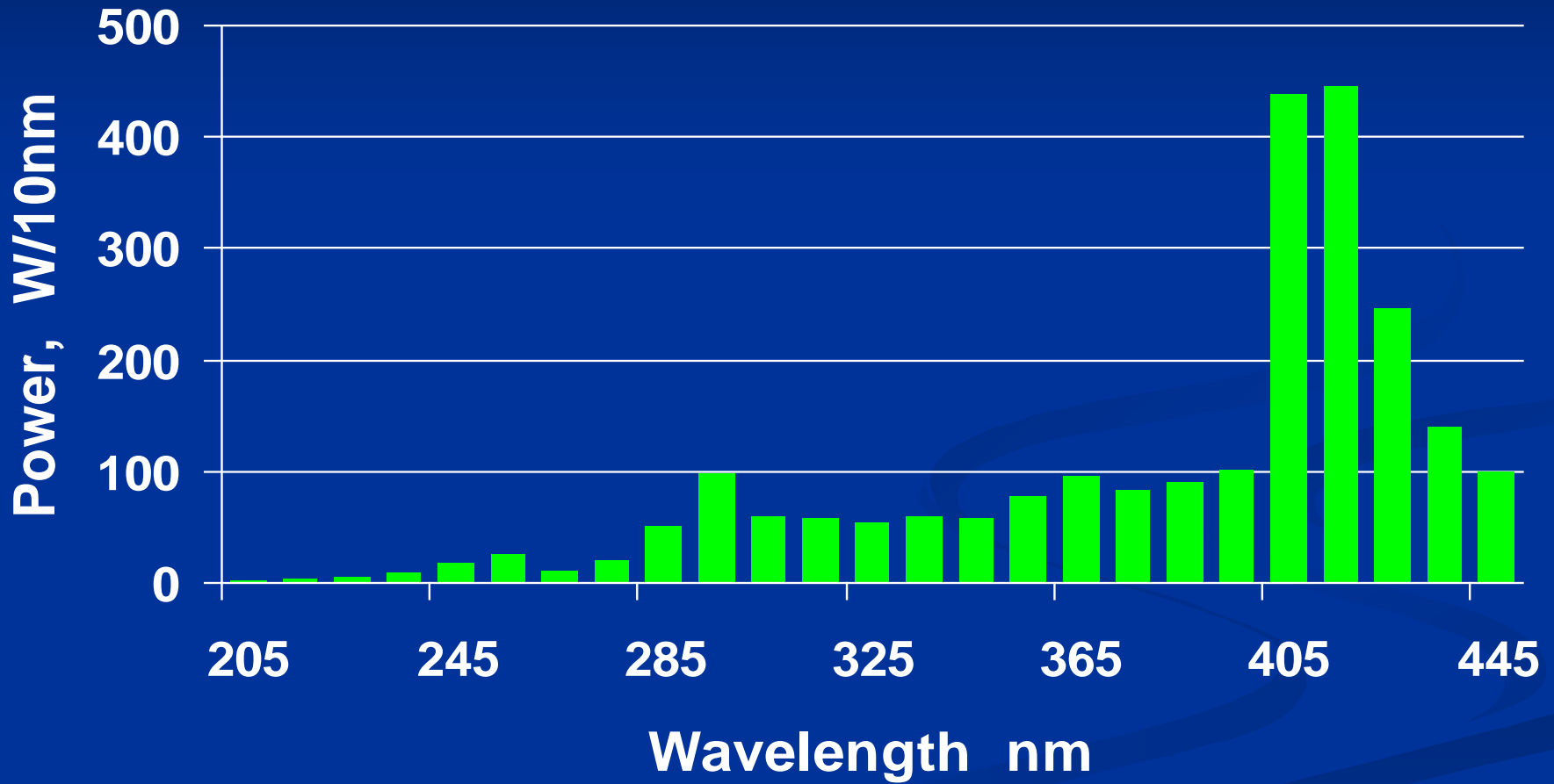


# D Bulb

Curing dark pigmented coatings

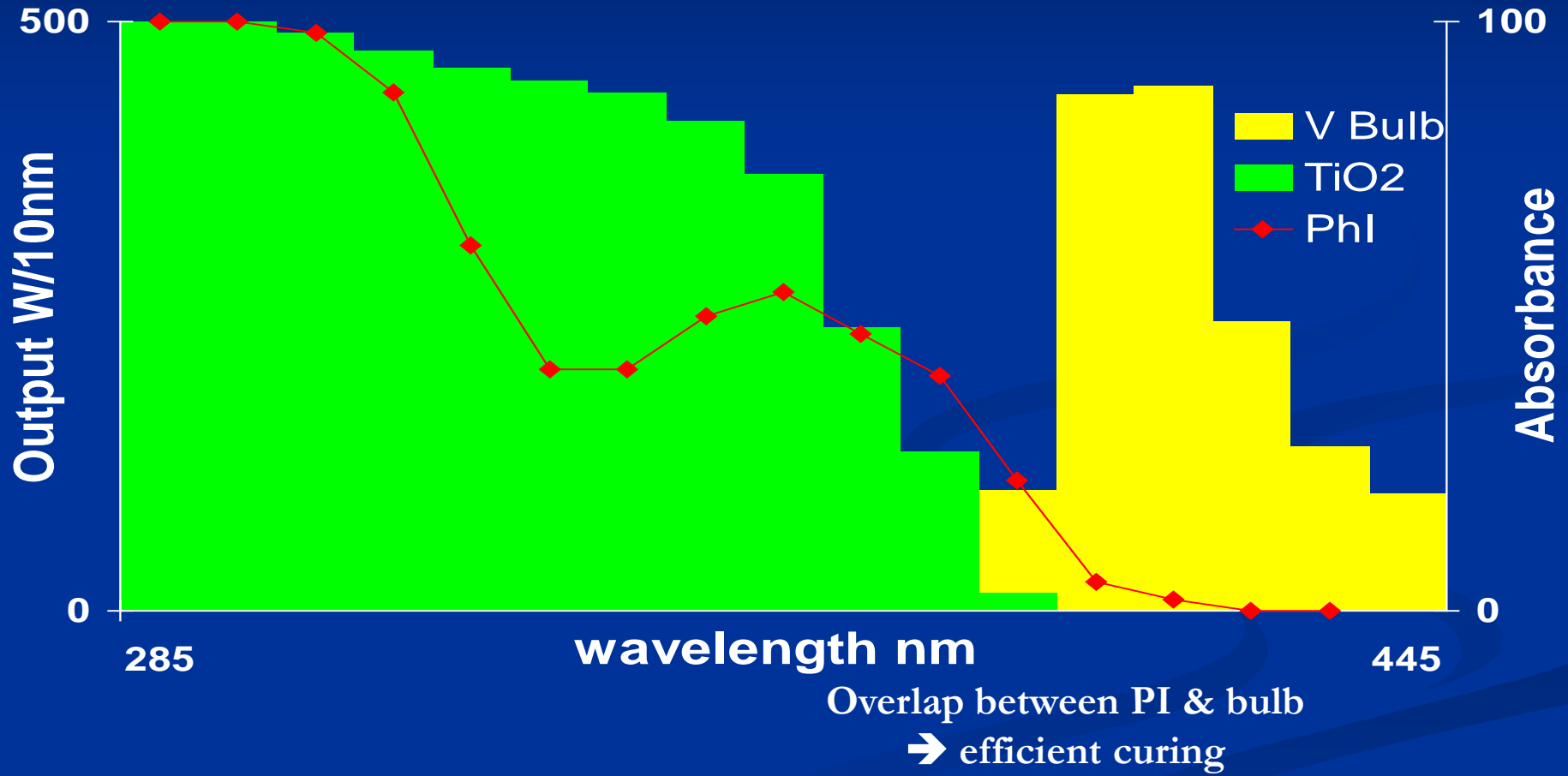


# V Bulb

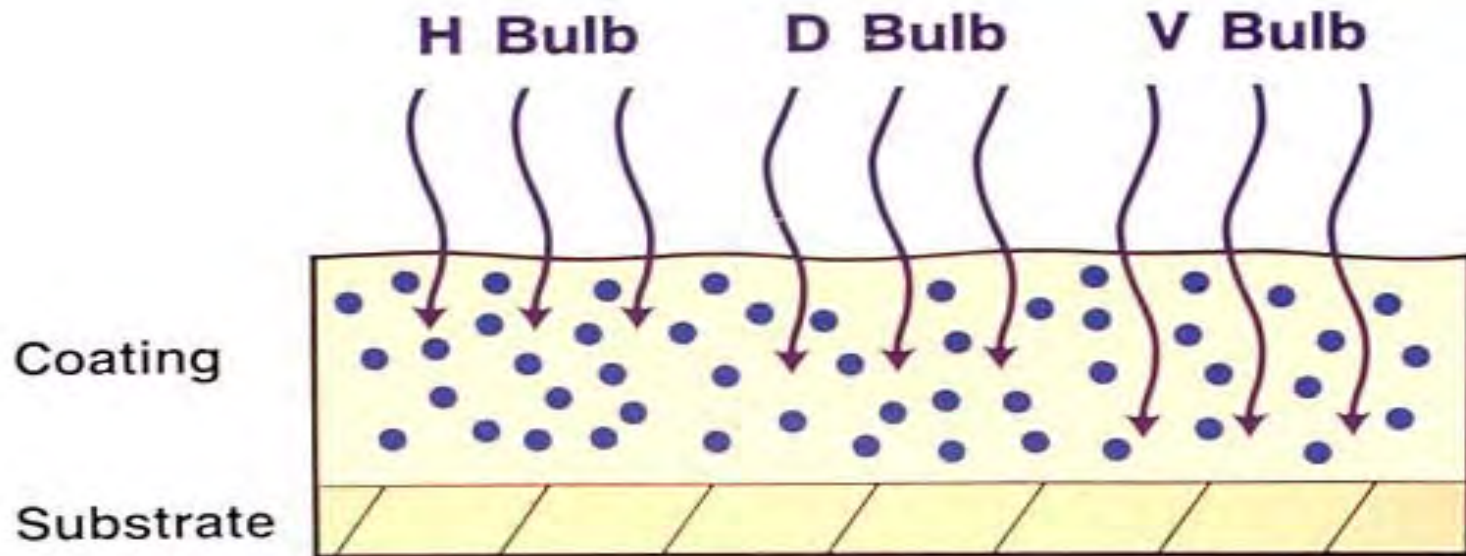


# V Bulb

Curing white coatings



# Depth of Cure for a Pigmented Coating





# UV Spectra & Optimal Processes

- **H-bulb**

Clear lacquers, adhesives, silicone release coatings

- **D-bulb**

Inks and pigmented systems, industrial bonding adhesives

- **V-bulb**

White pigmented coatings, visible light curing systems

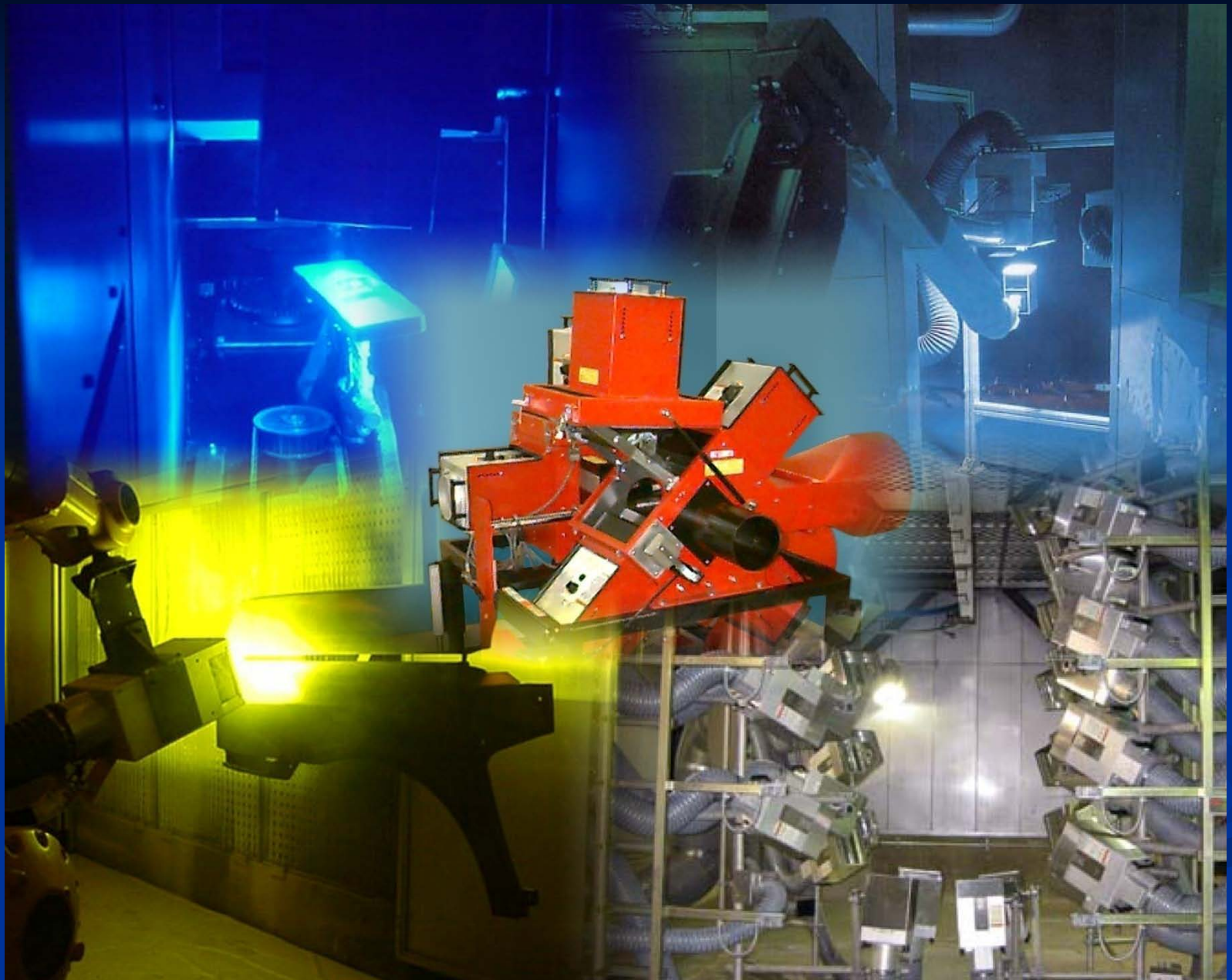
# Principles Summary

- ◆ Select longer wavelength UV for improved depth of cure
- ◆ Select bulb spectra to match the absorption profile of PhI
- ◆ UV coatings can be responsive to intensity as well as dose

# Microwave Lamp System



# UV Processing



# PRODUCT

Application Method  
Film Weight  
Process Speeds  
Target Properties  
Substrate

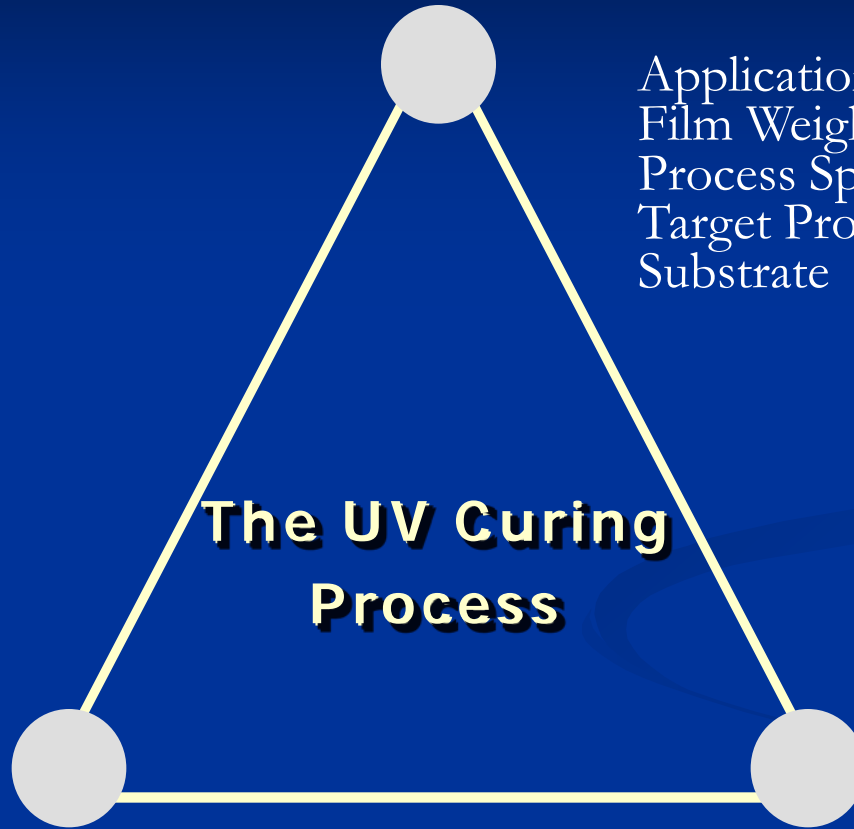
## The UV Curing Process

Irradiance  
Spectral Radiance  
Energy/Dose  
Infra-Red

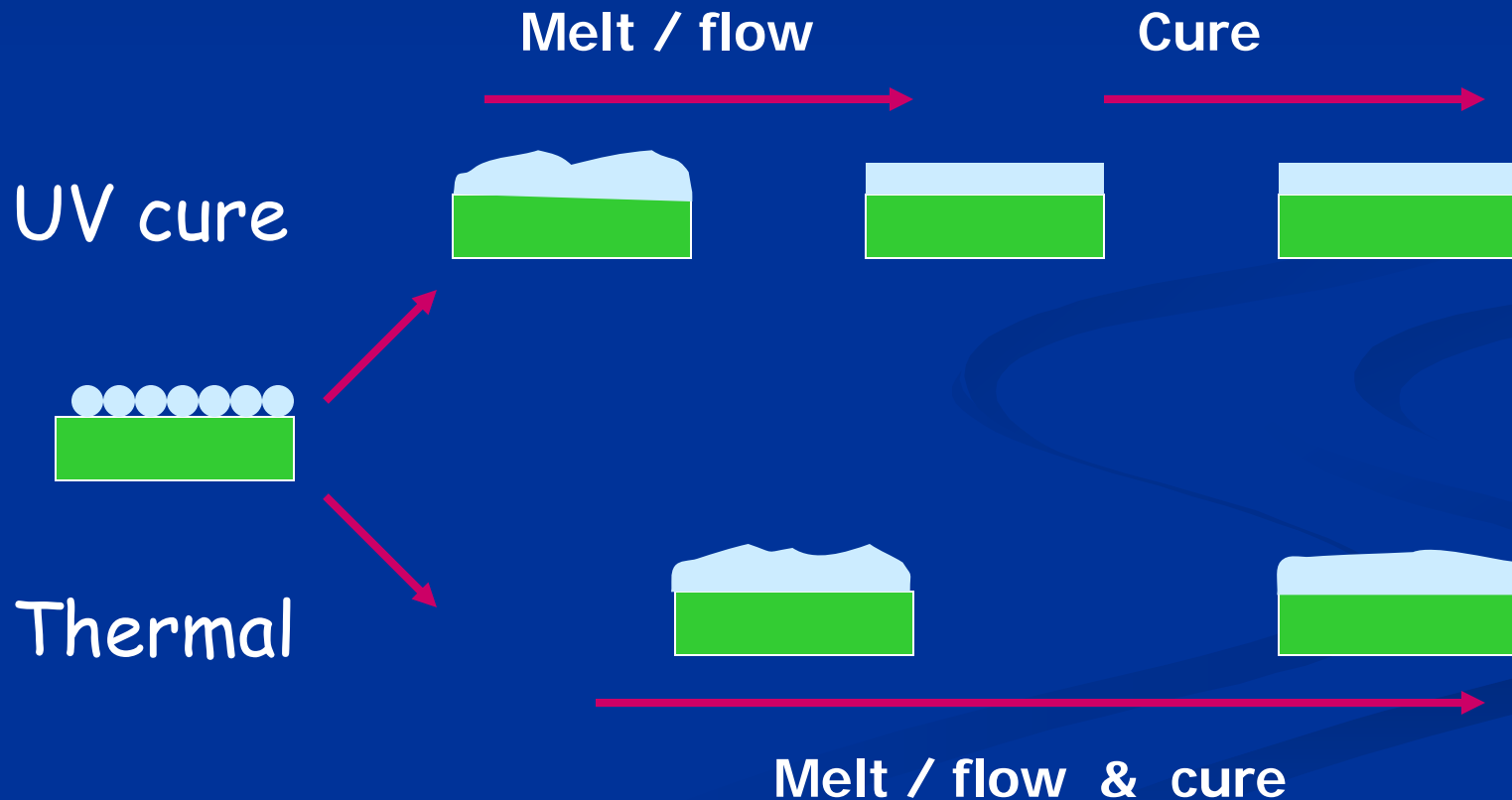
# LAMPS

Constituents  
Spectral Absorption  
Spectral Response  
Optical Thickness

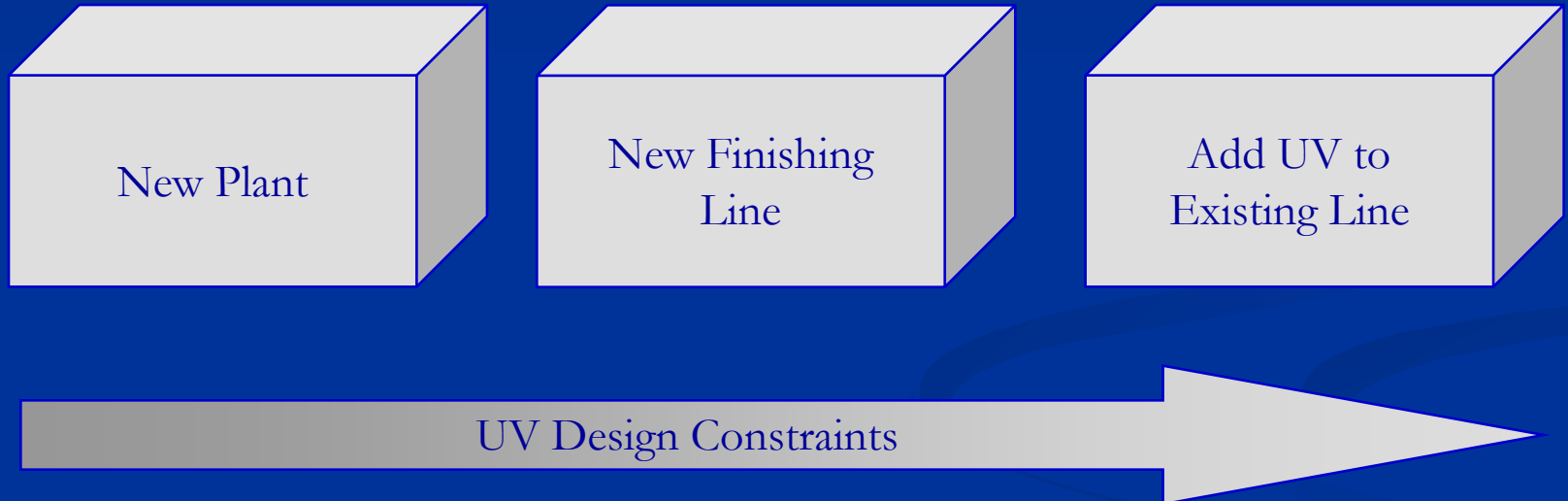
# FORMULATIONS



# UV curable powder coatings



# 3D UV Design





# 3D Process Options

Parts

Lamps

Static

Static

Single Movement

Single Movement

Complex Movement

Complex Movement



# Flat Line



# Single Array



# Primary Factors

- UV energy curing requirement
- Productivity
- Part size, geometry, and orientation
- Critical performance surfaces



# Advantages of UV powder coatings

- Lower temperature curing
  - Can be used on heat sensitive substrates
- Longer open time after melt stage
  - Better control over film formation
- Faster cure, more compact oven, higher throughput
  - More cost effective finishing operation



# Challenges for UV powder

- Understand the potential markets
  - Size, technical issues, be realistic
  - Target efforts of all partners into realistic opportunities
- Understand economics of each case
  - Process understanding, individual approach
- Understand the real needs and drivers of the end user
  - Willing to take on a new technology, invest in new equipment
- Teamwork
  - Powder formulator, Powder application equipment, Substrate supplier, IR & UV equipment supplier

# Why use UV powder coatings on MDF

- Reduce VOC emissions
- Faster curing
- High build films applied in one coat
- Replace laminates on kitchen furniture with a coating
- Good application on profiles
- Remove edge banding & coat irregular shapes more easily

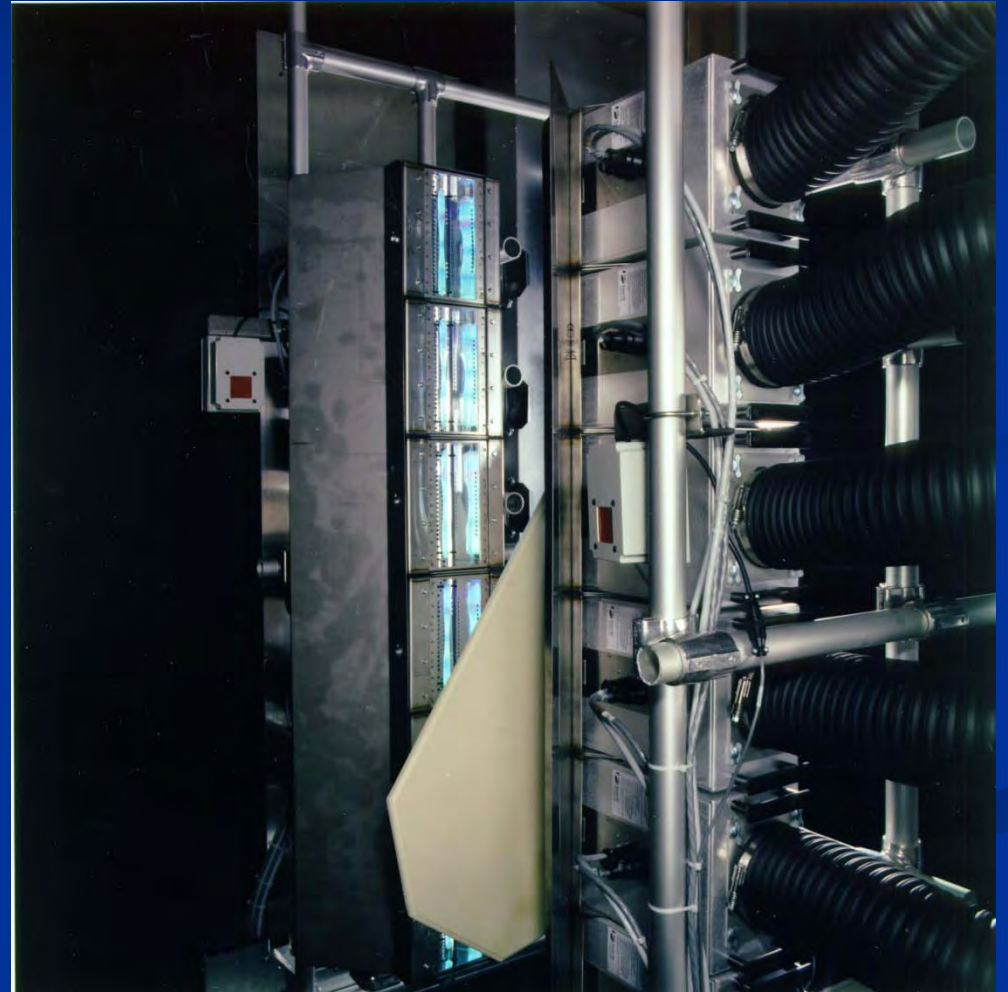
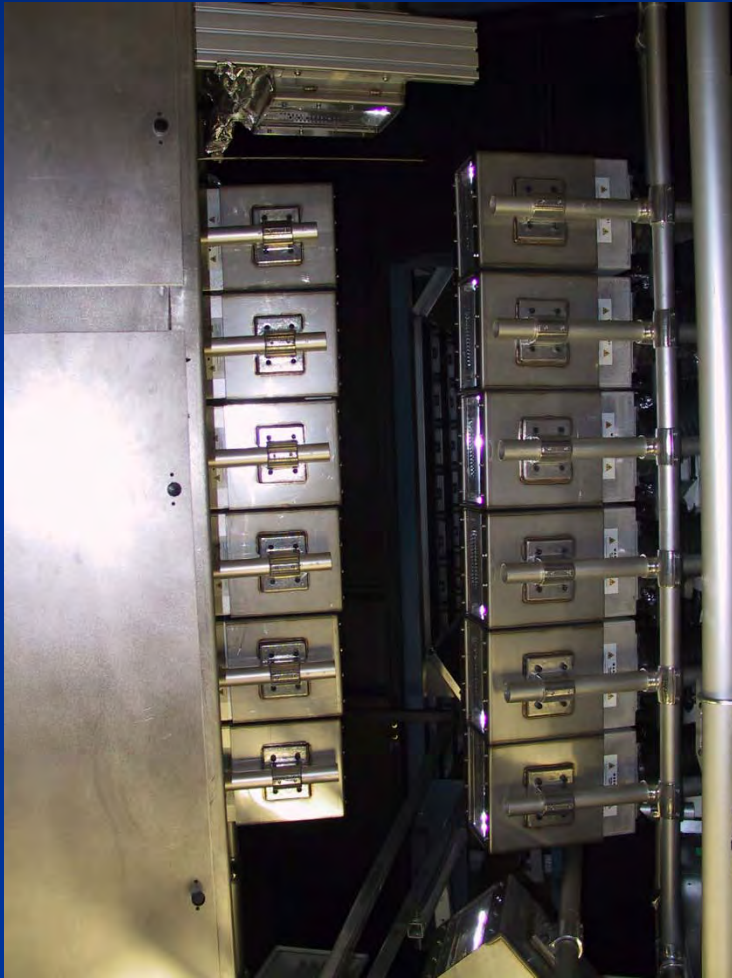
# Problems with coating MDF

- Moisture content of MDF
  - High moisture leads to pinholing cause by outgassing
  - Low moisture means the MDF has low conductivity and is difficult to coat electrostatically
- Non uniform MDF density
- Difficult to get even coating thickness on sharp edges

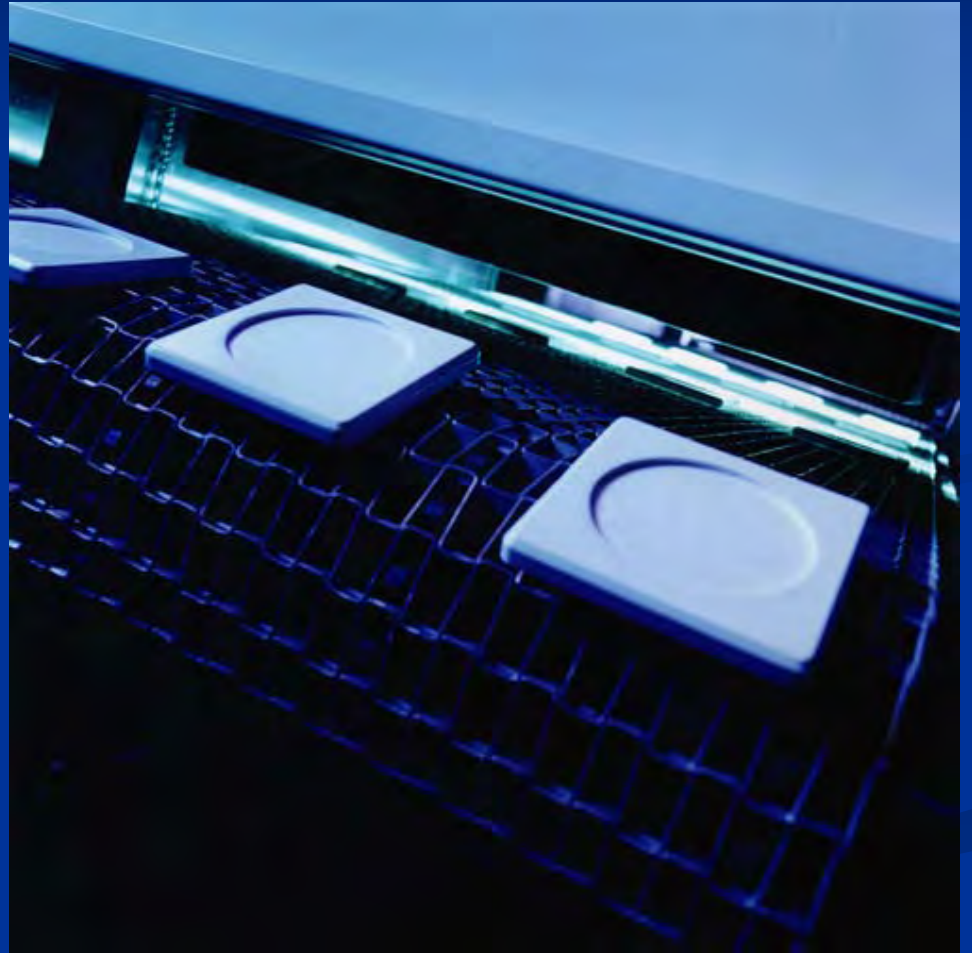
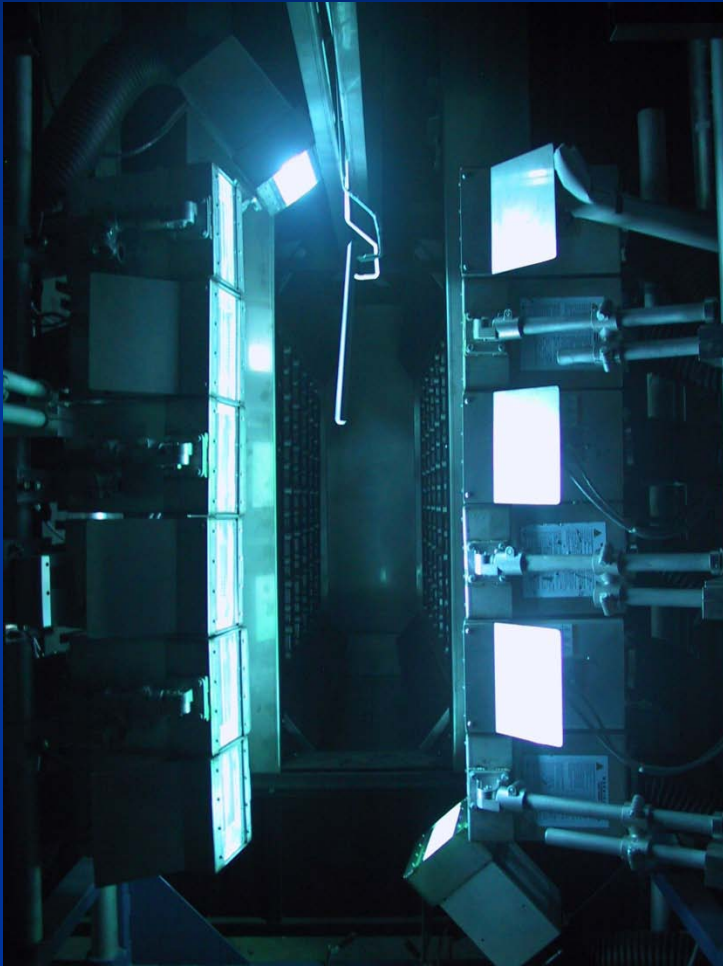
**Market driven by technological and ecological advantages**



# MDF UV Curing



# MDF UV Curing



# UV powder coating:the first success!



Baldor Electric Motor  
Co., USA -1998

Powder coating of pre-  
assembled motors

- Previously parts coated separately with solvent based coatings
- Clear powder coating applied to assembled motor
- Cured without harming heat sensitive internal components
- Reduced production costs and increased throughput
- Process less labour intensive
- VOC 's reduced



# Coating process for motors

- Coated motors are pre-heated for 1minute using short wave IR
- Enter convection oven for 8-15minutes reaching 120 °C to melt & flow the powder
- Motors enter UV curing zone, rotating as they travel.
- Cured using 8 microwave lamps mounted around the motors.

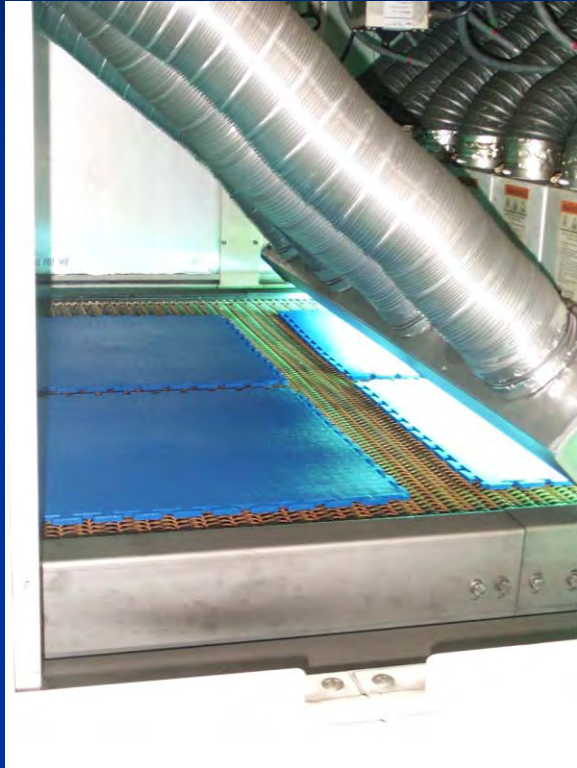


# Automotive radiators

- Radiator painted when fully assembled
- End user wanted to use powder coating for environmental reasons
- A rubber gasket meant a low temperature cure was needed
- Black powder applied and heated to 120°C. Cured using Fusion D bulb with high output in UVA region



# UV powder coatings for flooring



- Interlocking PVC floor tiles
- Quick easy installation
- Replacement floors in large industrial and commercial buildings
- Customers asked for better stain & scratch resistance
- UV powder coatings
  - Better coating performance
  - Low temperature cure cycle

# Summary

- A long and difficult road for development & commercialisation of UV powder coatings – but much still to recommend them
- High quality, durable coatings, faster processing, simpler processing
- Demand for environmentally acceptable coatings continues to grow
- Energy costs critical issue for all coating applications
  - UV curable powder coatings can provide solutions to fit all these criteria but need to assess economics carefully.

# UV Curable Powder Coatings

A challenge for the future

*THANK YOU  
FOR LISTENING*