UV Curing Process for UV Powder

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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

Latin America:
- Argentina
- Brazil
- Chile
- Colombia
- Costa Rica
- Mexico
- Puerto Rico
- Venezuela

- Indonesia
- Korea
- Malaysia
- Philippines
- Taiwan
- Thailand
- Australia
- India
- New Zealand
Standard Products
Optimize Spectral Output for Maximum Process Performance
UV Curing Principles

Factors Affecting Cure

- Irradiance
- UV Power
- Exposure Time
- UV Spectral Output Distribution
- UV Spectral Absorbion of the Coating
- Infrared Energy may need to be minimized

\[ \text{Exposure Time} = \text{Irradiance} \times \text{time} = \text{joules/cm}^2 \]
Key Elements of UV Curing Equipment

- **UV Energy J/cm²**
  - total energy arriving at the coating surface
  - inversely proportional to speed
- **UV Irradiance W/cm²**
  - 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 $W/cm^2$

- 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

Power, W/10nm

Wavelength nm

205 245 285 325 365 405 445
H Bulb

Overlap of bulb spectra & photoinitiator

Output W/10nm

Absorbance

Wavelength nm

H bulb
HMPP
Curing dark pigmented coatings

Output power W/10nm

Absorbance

D Bulb

BDMB

ITX

Surface cure

Wavelength nm

Through cure
V Bulb

Curing white coatings

Overlap between PI & bulb ➔ efficient curing
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
The UV Curing Process

PRODUCT
- Application Method
- Film Weight
- Process Speeds
- Target Properties
- Substrate

LAMPS
- Irradiance
- Spectral Radiance
- Energy/Dose
- Infra-Red

FORMULATIONS
- Constituents
- Spectral Absorption
- Spectral Response
- Optical Thickness

PRODUCT
LAMPS
FORMULATIONS
UV curable powder coatings

UV cure

Thermal

Melt / flow & cure
3D UV Design

New Plant

New Finishing Line

Add UV to Existing Line

UV Design Constraints
3D Process Options

Parts
- Static
- Single Movement
- Complex Movement

Lamps
- Static
- Single 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
UV powder coating: the first success!

- 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

Baldor Electric Motor Co., USA - 1998

Powder coating of pre-assembled motors
Coating process for motors

- Coated motors are pre-heated for 1 minute using short wave IR
- Enter convection oven for 8-15 minutes 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