Coatings Trends & Technologies SUMMIT

UV-A Cured Hard Coat Repair for Polycarbonate Head Light Lenses

Michael J. Dvorchak

Phone: 412-996-5225

E-Mail: miked@isharkskin.com




Outline

- Introduction
- Current products in the market
- OEM Style UV – A Refinish Hard coats for refinishing deteriorated PC head lights
- New advanced oligomer technology for PC refinishing
- UV – A light sources
- Conclusions
- References

Introduction

- Auto industry has changed from glass to polycarbonate plastics (PC) for weight reduction and safety.
- Deterioration over time of the UV cured hard coat used to protect the PC head light
- Today there is an estimated 278 million vehicles in the US
- A total of 556 million PC head lamps
- Average age of a vehicle in the US is 12.2 years
- Technology for repair ranges from tooth paste to an OEM style 1 K UV – A refinishing hard coat

Current products in the market to solve the deteriorated PC head lights

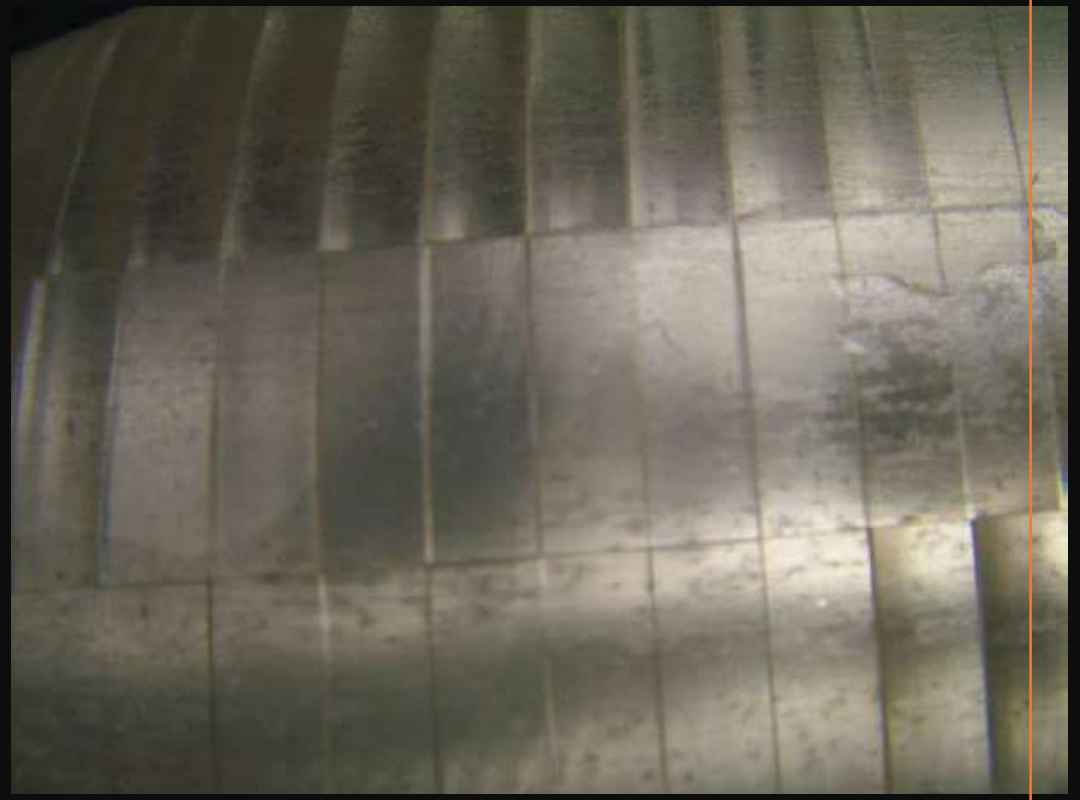
- **This PC head lights output as measured by a Hoppy Vision 100 light reader gave the following values:**
  - **LOW BEAM; 3,000 Candela**
  - **HIGH BEAM; 7,000 Candela**

Products introduced to resolve the deteriorated PC Head Light UV Cure Hard Coat

- Sanding and polishing to rejuvenate the deteriorated PC Head Light [1]
- Removal of the deteriorated PC hard coat and application of a sealant reported to last 2 years [2]
- Of the 20 techniques surveyed half reported using only a sanding and polishing technique while the other half reported using a sealant after removal of the deteriorated UV hard coat
- Another reports the use of a 2K PUR that is traditionally used in the auto refinish market [3]

Introduction of an OEM style UV – A refinish hard coat to repair deteriorated PC head lights

- In 2005 a repair technique was introduced that used polymer technology that mimic the OEM style UV cure hard coats [4]
- Two patent applications were submitted in 2004 [5] and 2005 [6] that reports the removal and application of a sealer or coating.
- Regardless of the technique employed; the ability to upgrade the head lamp close to the original standard is important to the vehicle owner



OEM Style UV – A Refinish Hard coats for refinishing deteriorated PC head lights

- Using technology from the OEM UV hard coat technology was incorporated in a paper that describes new oligomer technology [7]
- The PC head light itself is already protected with UV-absorbers and HALS-amines
- In addition; the UV hard coat formulation needs to incorporate UV-absorbers and HALS-amines

OEM Style UV – A Refinish Hard coats for refinishing deteriorated PC head lights

- Formulation is the type and style of a formulation that has a proven track record in the OEM automotive headlight environment

Formulation	Function	% by weight
UV-curing oilgomer	resin	80
Monomer	react. thinner	80
BAPO	UV-initiator	4.9
Additive	leveling agent	1.6
Additive	UV-absorber	3.8
Additive	HALS-amine	1.7
Curing	1,800 mJ/cm² (Hg spectrum)	
DFT	ca. 25 µm	
Substrate	PC (UV-absorber/HALS-amine)	

OEM Style UV – A Refinish Hard coats for refinishing deteriorated PC head lights

- This table shows the relationship of high-performance UV oligomers used in the OEM UV Hard coat market

Weathering data			
Urethane Acrylate	**ISO11341 Xenon Test**	**CAM 180**	**UV - B**
ECHO	> 5000 h	5000 h	2500 h
Fox Trot 1	3750 h	3250 h	2500 h
Alpha 1	>4000 h	>4000 h	2500 h
Bravo 1	5000 h	5000 h	2500 h
Delta 1	3000 h	3000 h	2500 h
Test parameters: Chalking, adhesion, cracks, blisters			

OEM Style UV – A Refinish Hard coats for refinishing deteriorated PC head lights

- **PC head lights output as measured by a Hoppy Vision 100 light reader gave the following values:**
  - **LOW BEAM before refinishing; 3,000 Candela**
  - **LOW Beam after refinishing; 7,000 Candela**
  - **HIGH BEAM before refinishing; 7,000 Candela**
  - **HIGH BEAM after refinishing; 17,000 Candela**

Advanced oligomer technology for the PC Head Lamp refinishing market

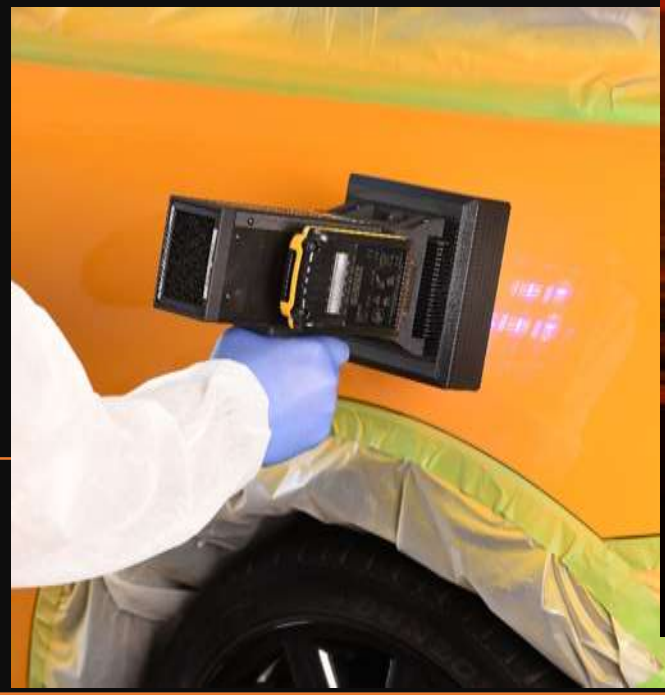
Urethane Acrylate	Alpha 1	Bravo 1	Echo	Delta 1
Form supplied	*100 %*	*100 %*	*80% (20% monomer)*	*100 %*
Type; aliphatic urethane	*allophanate*	*allophanate*	*polyisocyanurate*	*allophanate*
Viscosity (23 °C, mPas)	*ca. 60,000*	*ca. 35,000*	*ca. 34,000*	*ca. 8,000*
Hazen colour value	*< 100*	*< 100*	*< 100*	*< 100*
Molecular weight, g/mol (GPC)	*ca. 1,100*	*800*	*1,400*	*1,250*
Functionality cal.	*ca. 4*	*ca. 3*	*ca.3*	*ca.3*
Double bond density , Val/kg	*ca. 3.8*	*ca. 4.1*	*ca. 1.6*	*ca. 2.8*
UV reactivity (3 %, Dar. 1173, 1 lamp 80 W/cm)	*ca. 25 m/min ca. 140 mJ/cm²*	*ca. 10 m/min ca. 450 mJ/cm²*	*ca. 20.0 m/min ca. 155 mJ/cm²*	*ca. 7,5 m/min ca. 450 mJ/cm²*
Pendelum hardness	*ca. 140*	*ca. 170*	*ca. 180*	*ca. 60*
Tg in °C	*ca. 65*	*ca. 80*	*ca. 75*	*ca. 30*
Elongation at break in %	*ca. 4*	*ca. 3*	*ca. 2*	*ca. 17*
Tensile strength in N/ mm²	*ca. 65*	*ca. 40*	*ca. 20*	*ca. 22*
Special properties	*Balanced properties, high scratch resistance combined with high fct. oligomers.*	*Well balanced properties, good barrier against water and corrosive environment.*	*High reactivity and hardness, high resistance against mechanical and chemical attack.*	*Product is designed to adjust flexibility combined with the other allophanate urethane acrylates.*

Advanced UV Cure oligomer technology for the PC Head Lamp refinishing market

- This photo shows 36 months of service in the North-Eastern part of the US.
- Only limited degradation to the OEM Style Refinishing UV – A Cured Hard Coat is found.

UV – A cure light sources for use within the automotive PC head light refinishing market

- Top Photo - shows the development of a UV – A curing lamp for use in refinishing deteriorated PC head lights
- Bottom Photo – New hand held LED unit that uses traditional hand tool battery supply for potential use in PC head light repair
- Side Photo – A lot of these products will sunshine cure (visible light photoinitiator)



Conclusions

- The need for a OEM Style 1 K UV – A refinish hard coat is obvious when you realize that there are over 556 million PC head lights in service today in the US
- With the average age of US vehicles hovering at 12.2 years; even 10 % of that market is a large new area for UV cure
- The development of a OEM Style 1 K UV – A refinish hard coat will hope to resolve this important safety issue
- The use of the allophanate oligomer chemistry offers technology that will not require additional monomers

References

1) 3M 39008 Headlight Lens Restoration; http://3mauto.com/products/headlight-restoration
2) Philips HRK00XH Headlight Restoration kit; http://www.p4c.philips.com/cgi-bin/cpindex.pl?ctn=HRK00XM&hlt=Link
3) The Illuminator; Cumberlandproductsinc.com; introduced at the SEMA show in 2011
4) Subramanian, R; UV Refinish for Plastic Headlamps, UV EB West 2005
5) US 7,404,988; Headlight Lens Resurfacing Apparatus and Method; , Terry, Mitchell Kunta
6) US 7,163,446; Vehicle Headlight Restoration; Cole et al.
7) Dvorchak, M. J., Henderson, K.A., Gambino, C.A., Acrylated Allophanate oligomers that are 100% solids with low viscosity and high functionality; RADTECH NA Conference, May 2010

Thank you for your attention!

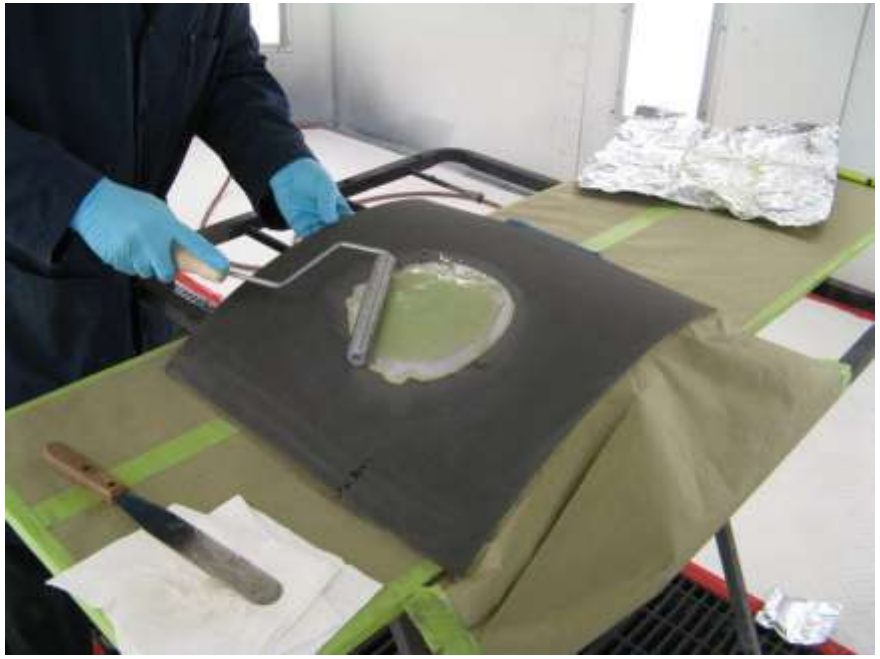
- Contact Information
- Michael J. Dvorchak
- Phone (cell); 412-996-5225
- Email; miked@isharkskin.com
- Web Site; dvorchakenterprisesllc.com

BACK UP SLIDES

Stencil UV A Coating F-16

C-130; Small Area Repair UV A

Military Applications
UV A Cure Battle Field Composite Repair



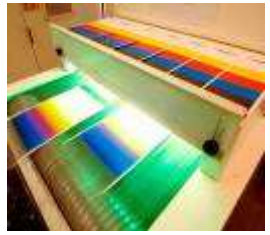
- KISS Principle
- Ballistic holes in composites
  - AK-47 or shrapnel
- Quick return to service
- Simple and quick process that returns the aircraft to service with eventual permanent repair at the depot
- Commercial air lines interested is this technique for remote location repair

*Registered Trademark of Bayer AG, Germany

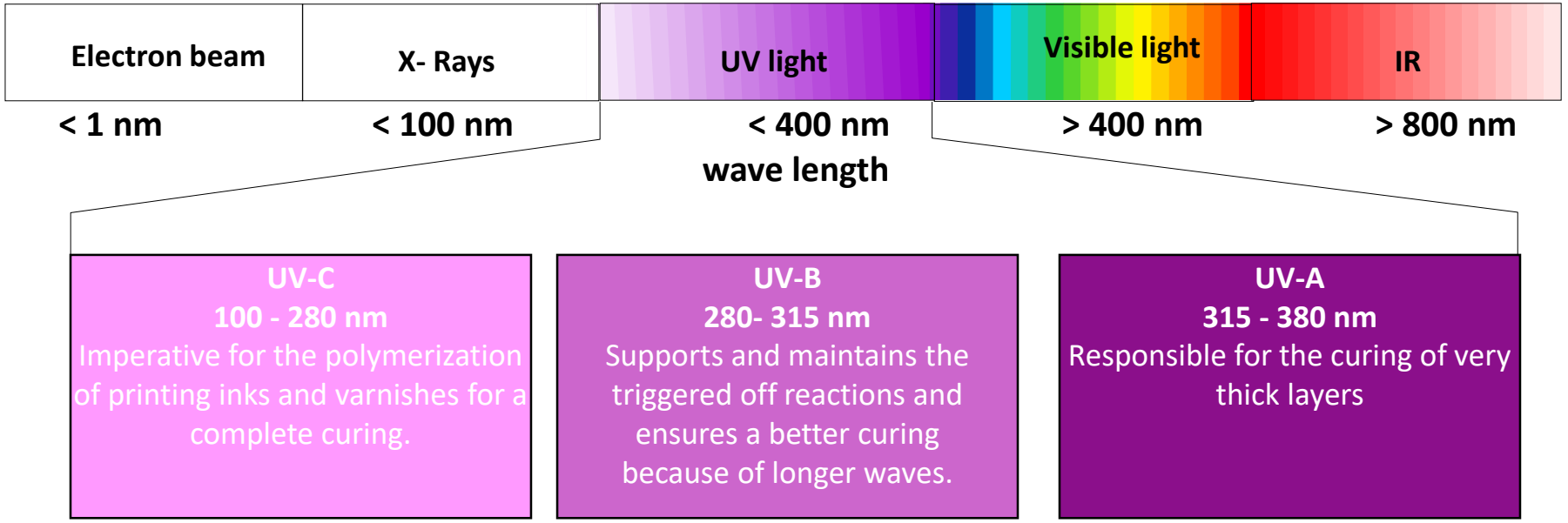
Basics of UV Curing

Curing of Coatings with electromagnetic radiation

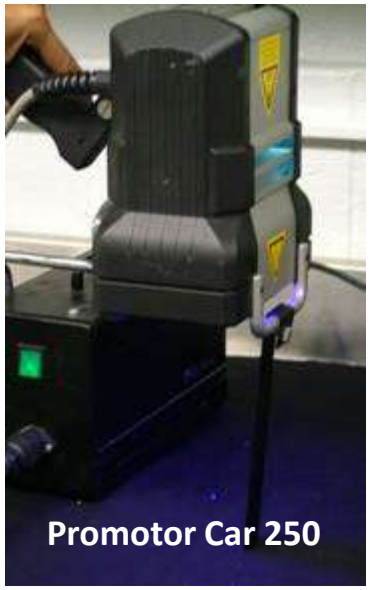
UV- or electron beam curing

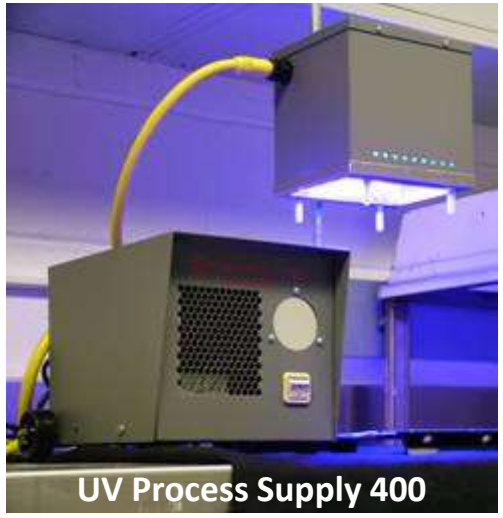


Curing conditions seconds/ milliseconds



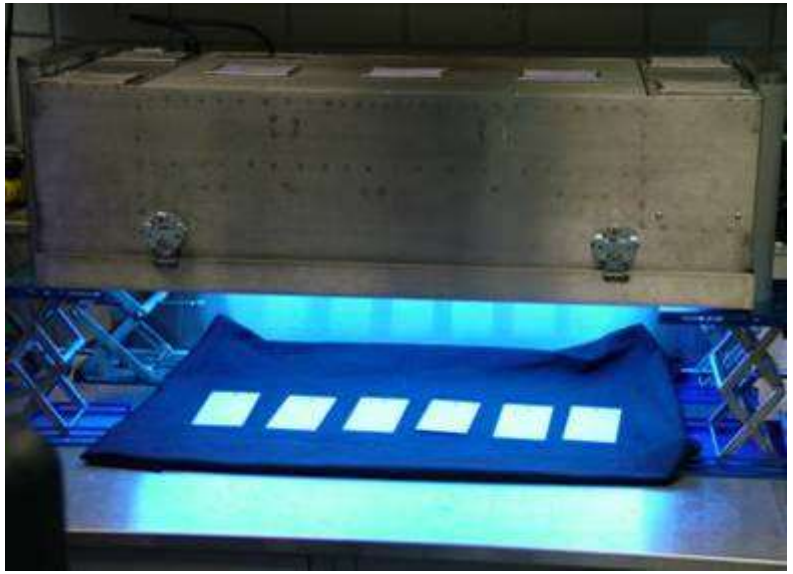
Low Energy UV-A Lamps



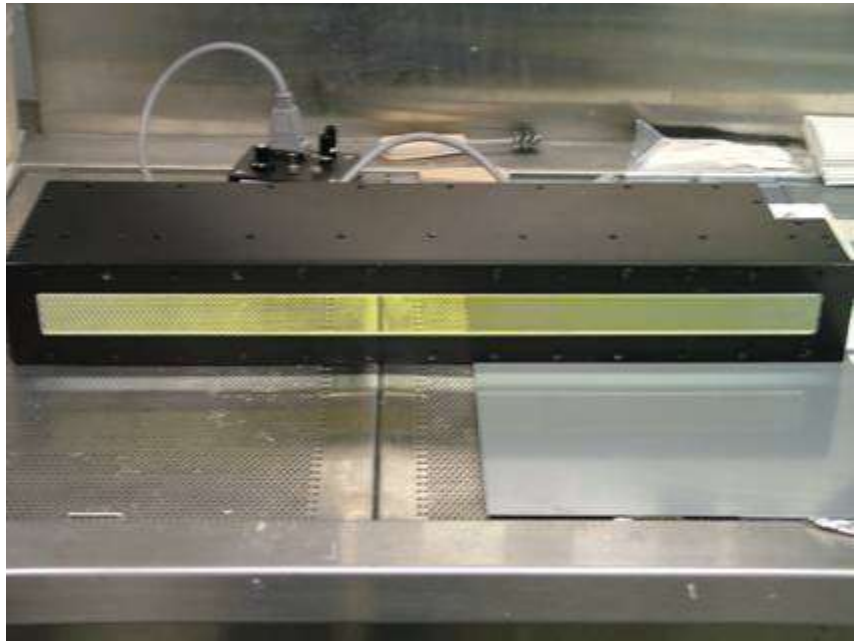


Low Intensity Microwave Lamp

- **Quantum Technologies**
- **Low powered lamps**
- **Current UV-A lamp assembly has a series of bulbs from 320 to 400 nm**
- **Bulbs can be made to desired wavelength output**



NEW UV-A Light Sources
Automotive Refinish/Aerospace & Printing



- **1,200 W UVA Light**
- **H & S Auto Shot**
- **LED UVA**
- **Phoseon Technology**