



中国感光学会辐射固化专业委员会  
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# Markets Overview and Progress of UV/EB Curing Technology in China

Jianwen Yang, Yongli Qv, Chen Tong  
RadTech China

RadTech NA, May 2016, Chicago USA



## Outline

- **UV Products Manufacture**
- **Advances of Materials & Technology**
- **New Trends of UV-curing Applications**
- **VOC Law**



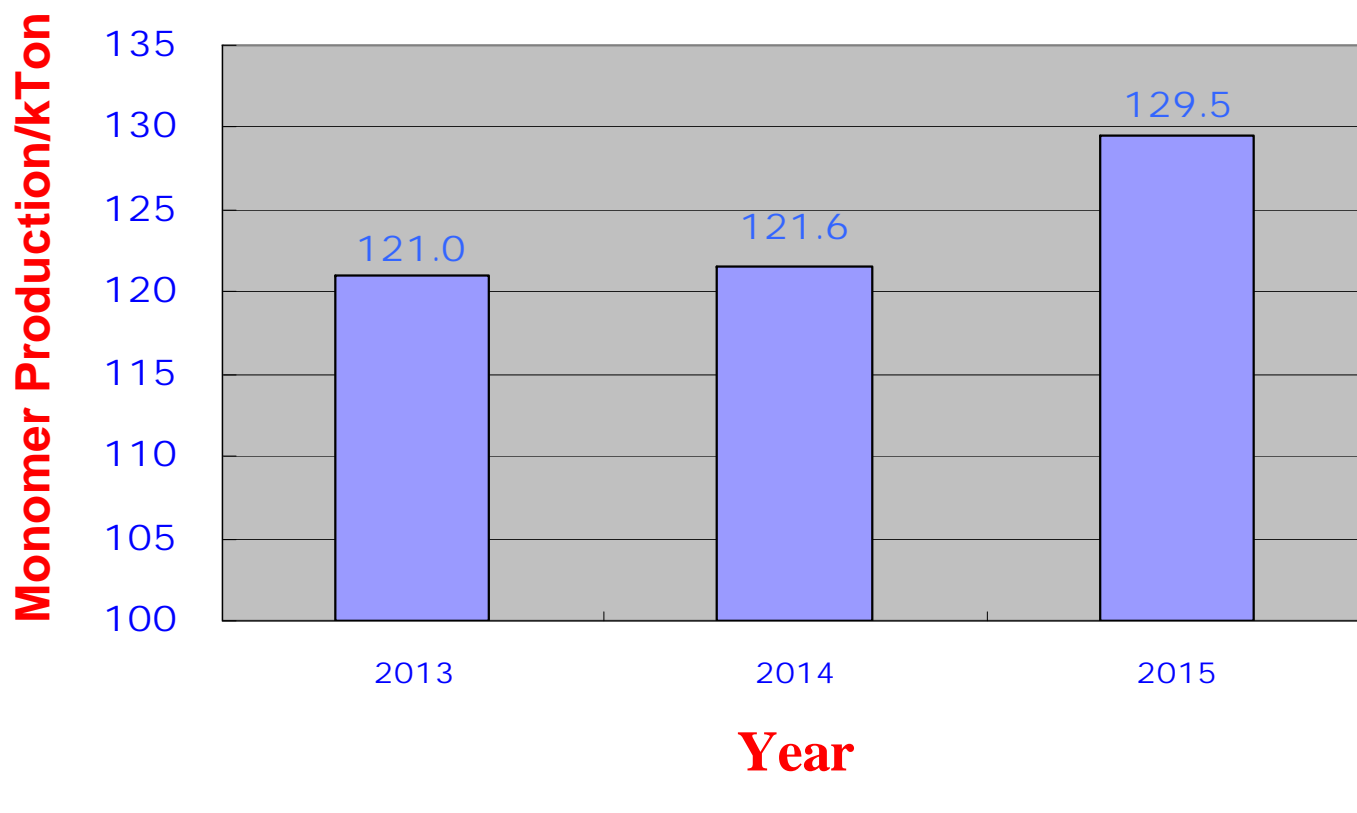
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## UV Products Manufacture

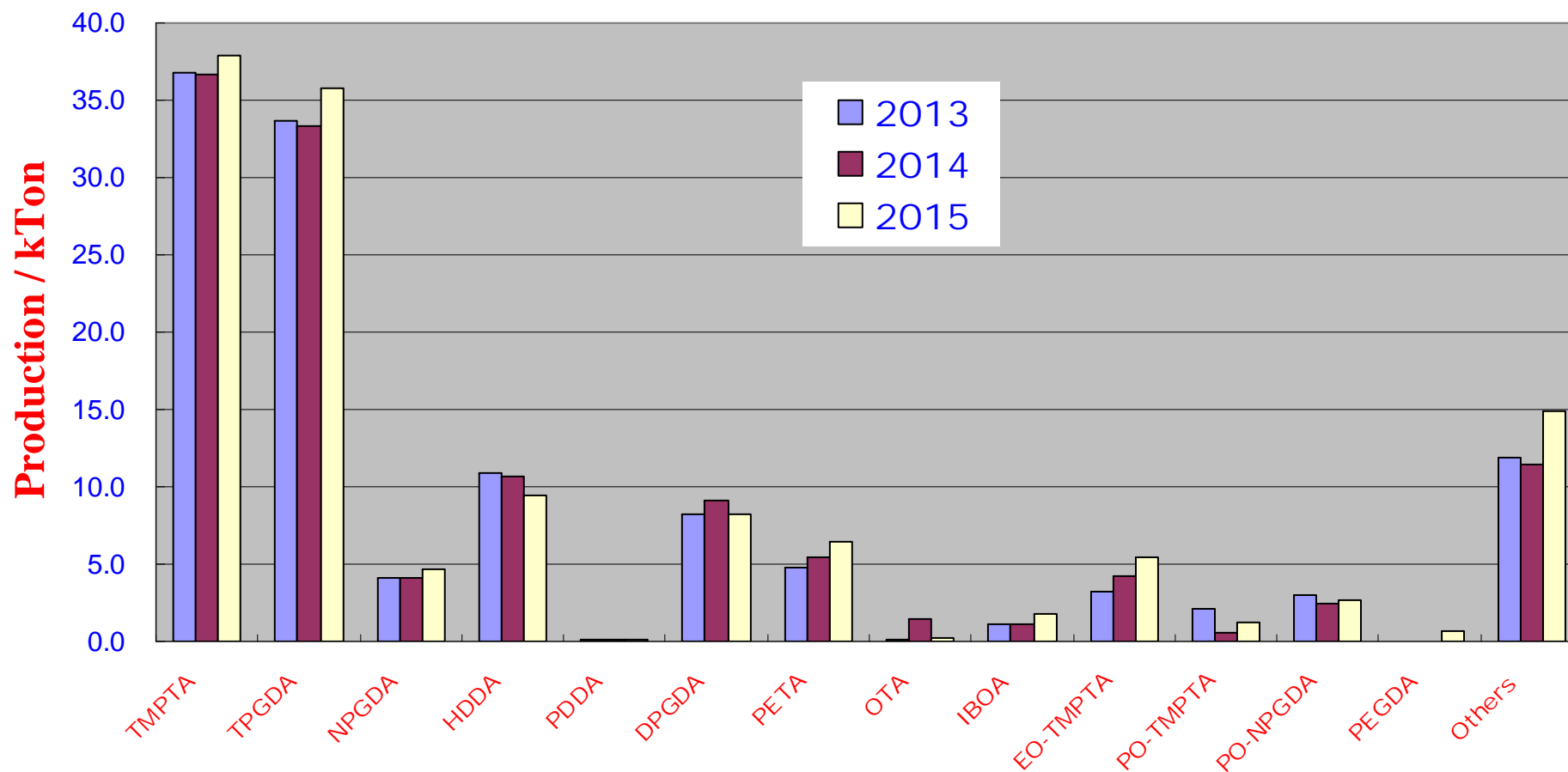
### Monomer Production

2013-2015 Monomer Production





## Monomer Production

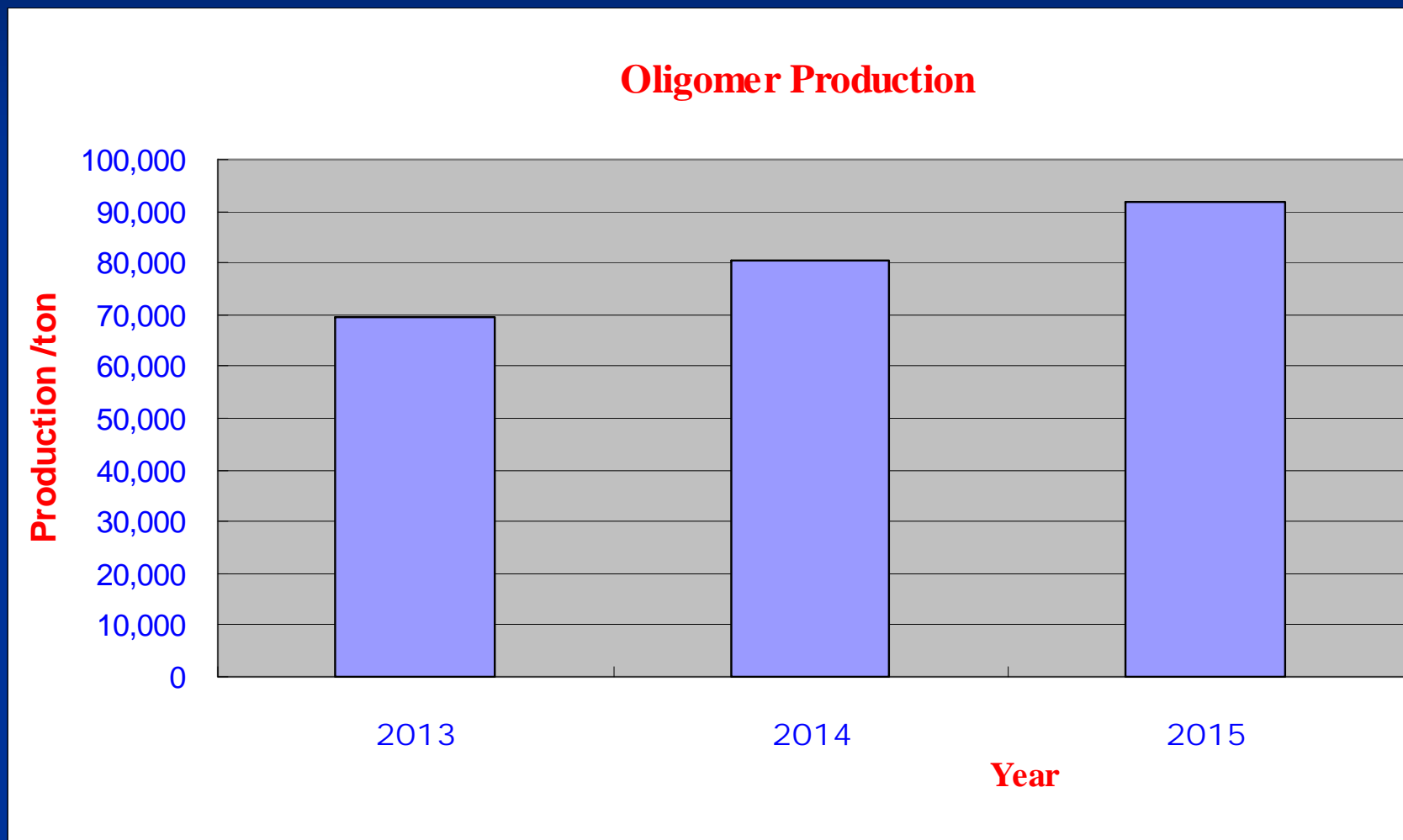




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## Oligomer Production



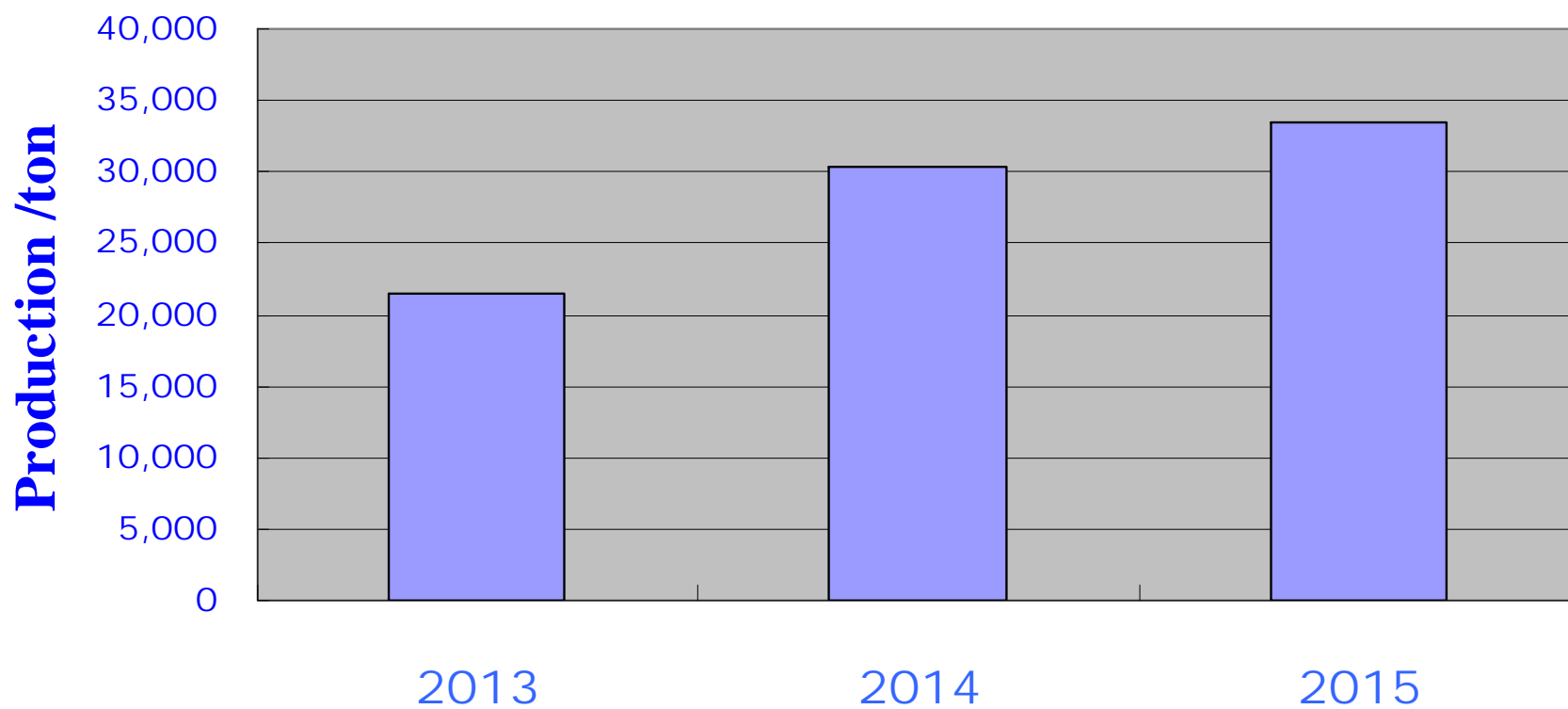


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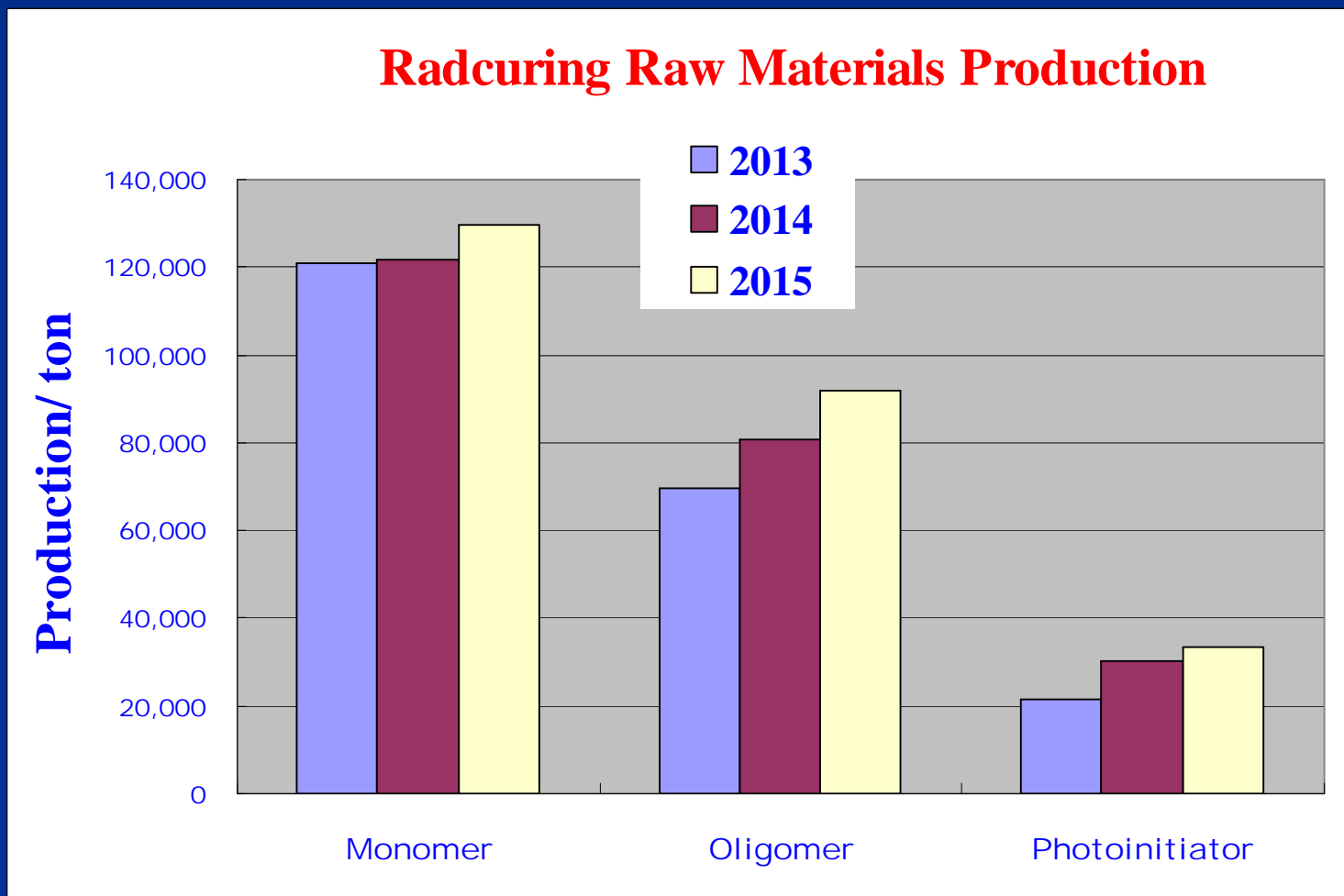
## Photoinitiator Production

### Photoinitiator Production





## Radcuring Raw Materials Production



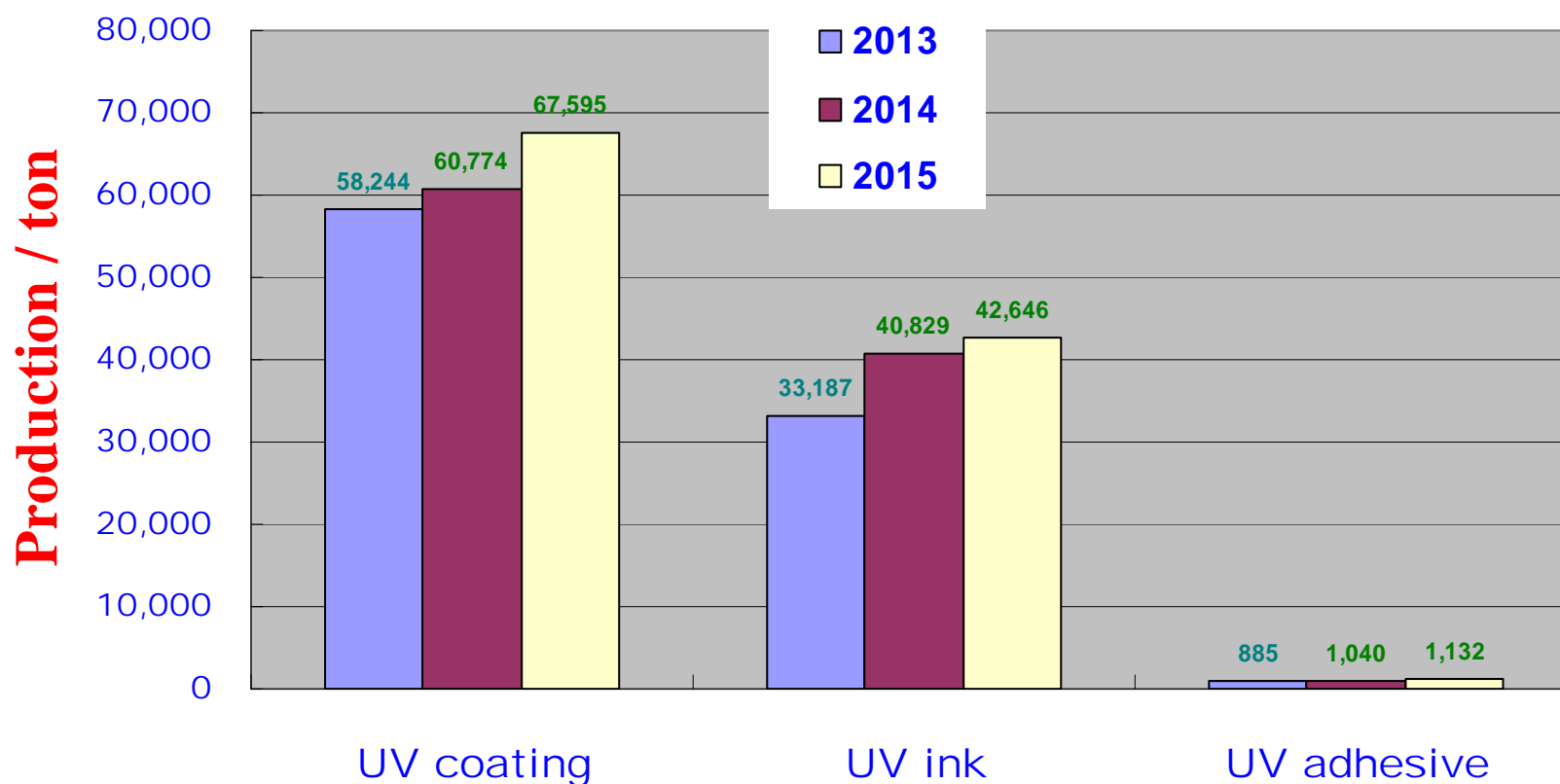


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## Radcuring Formulation Production

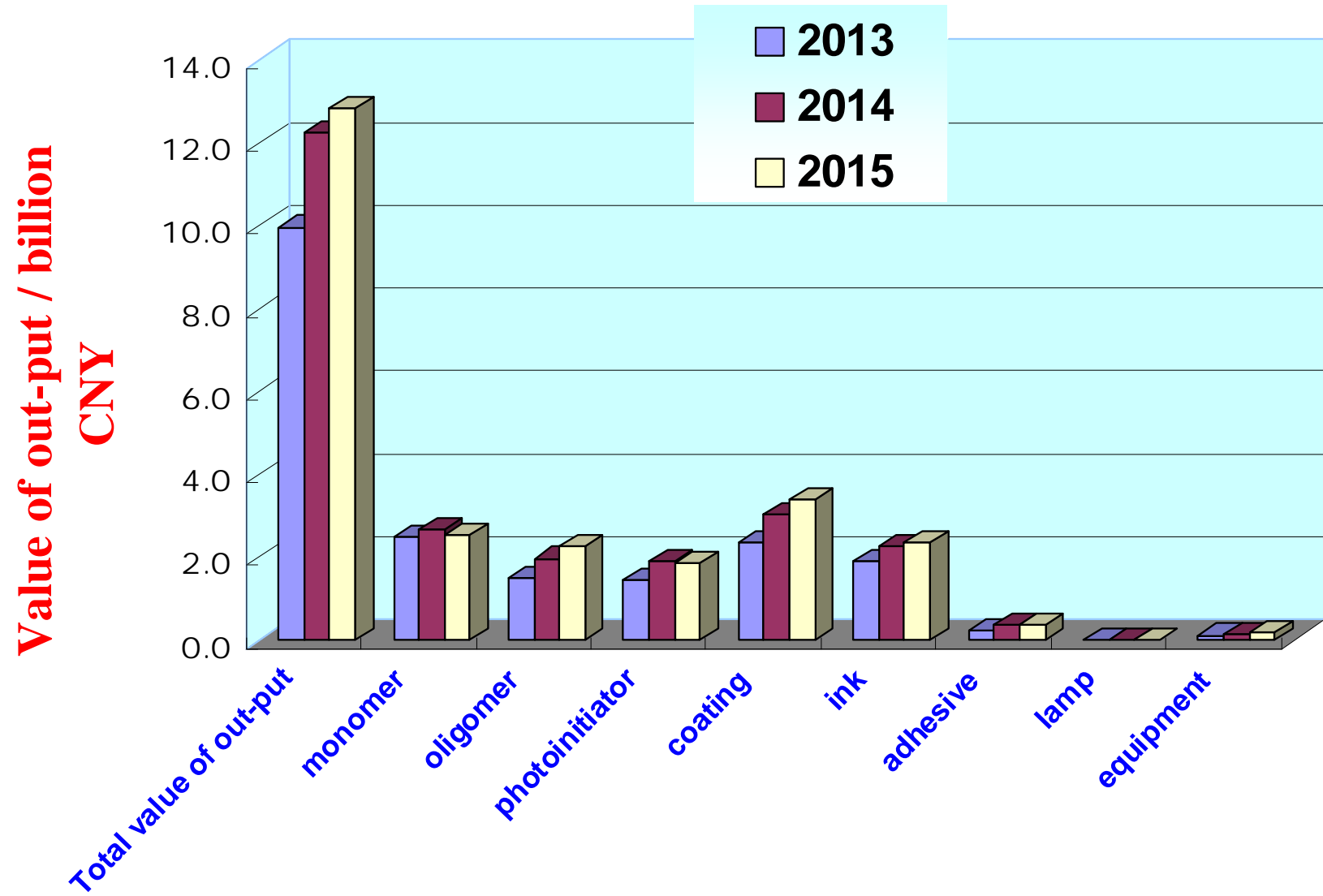
### Radcuring Formulation Production







### Value of out-put





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- **VOC Law**

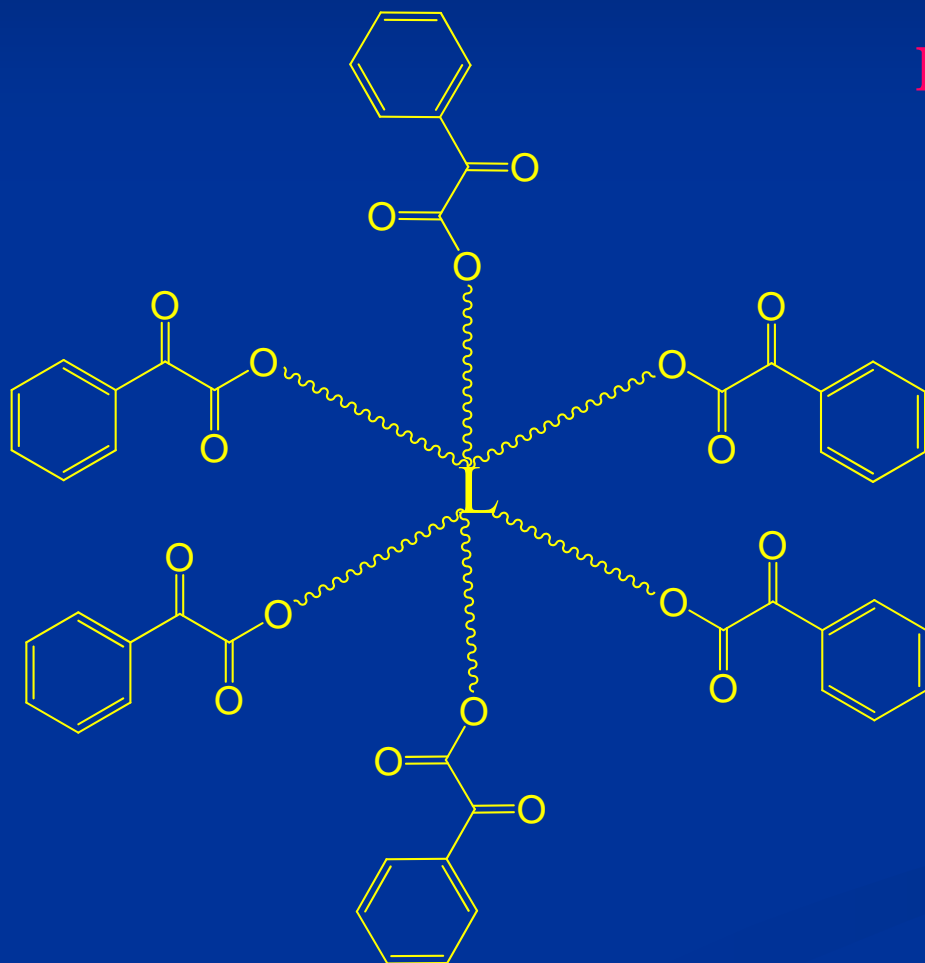


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## Photoinitiator Development & Production

**Poly functional Photoinitiator**



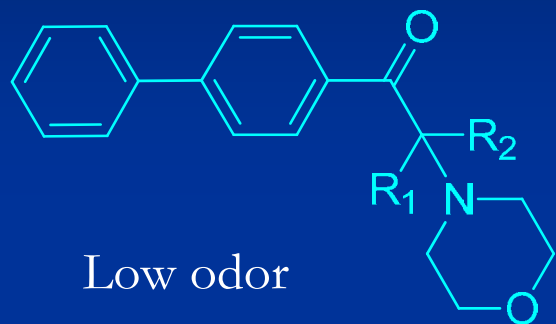
Reduce odor

Increase efficiency



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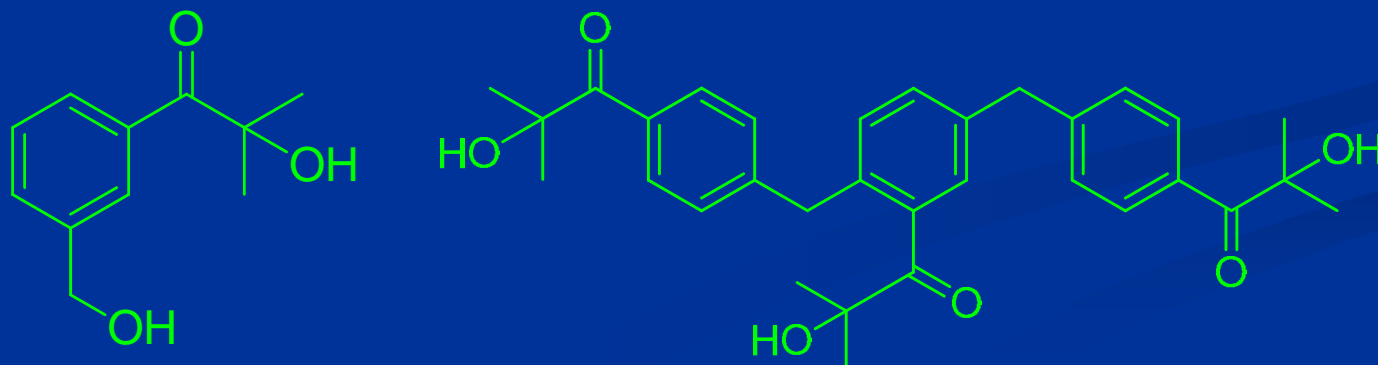
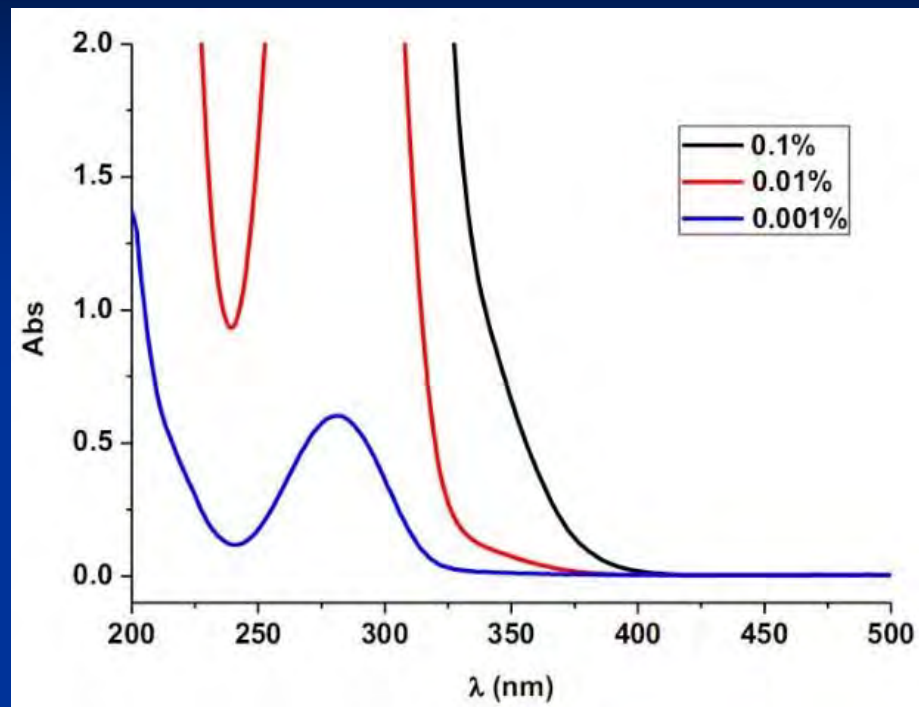
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Low odor

High efficiency

Replace Irgacure 907

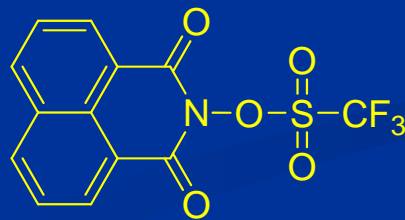
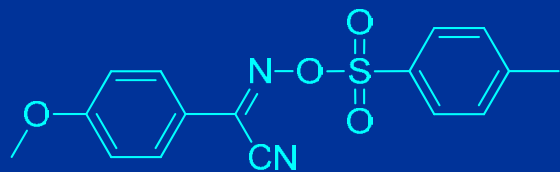
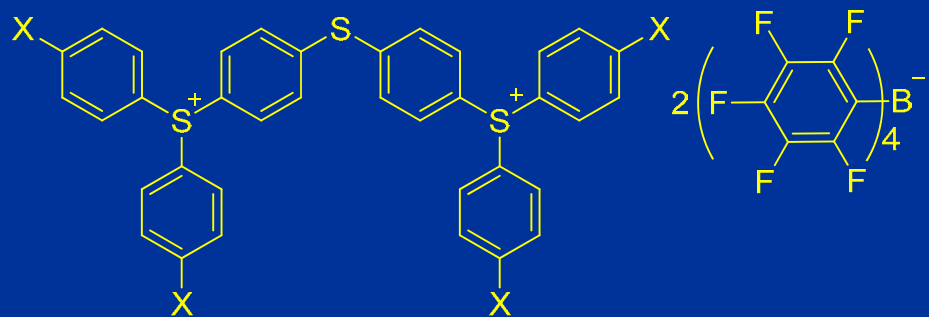
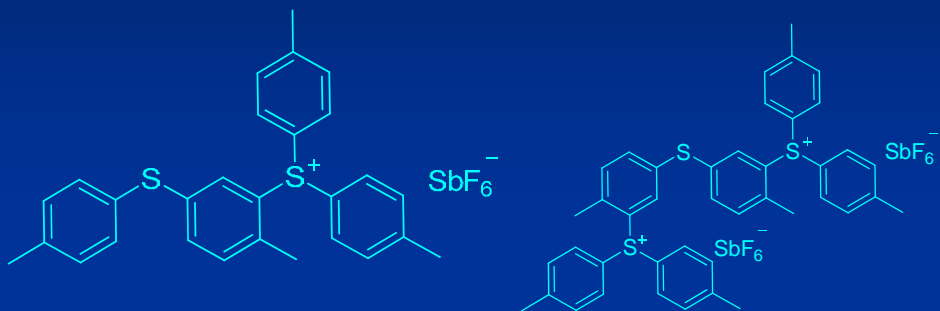




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## Photoacid generator (PAG)

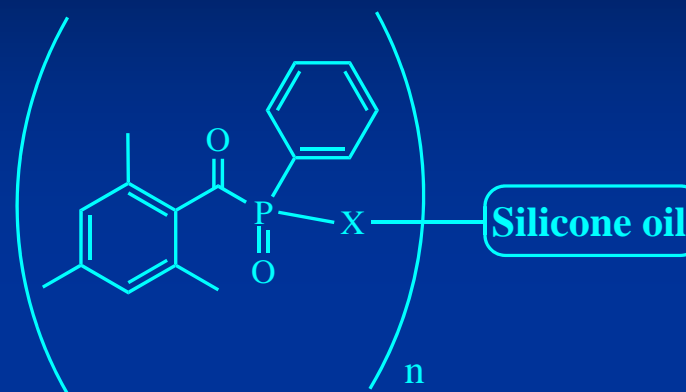
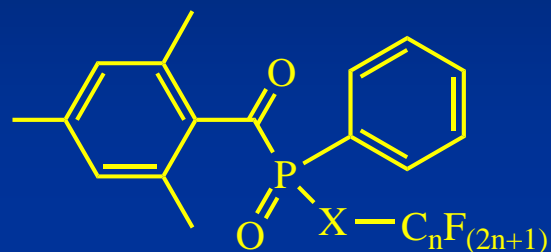




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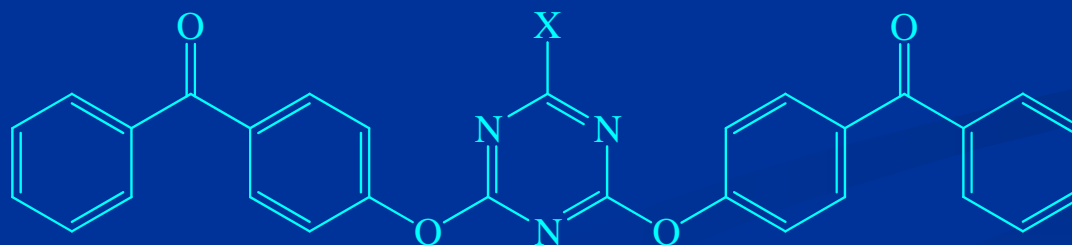
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## Floating TPO



Kill oxygen inhibition in UV LED curing

## Multi-functional BP



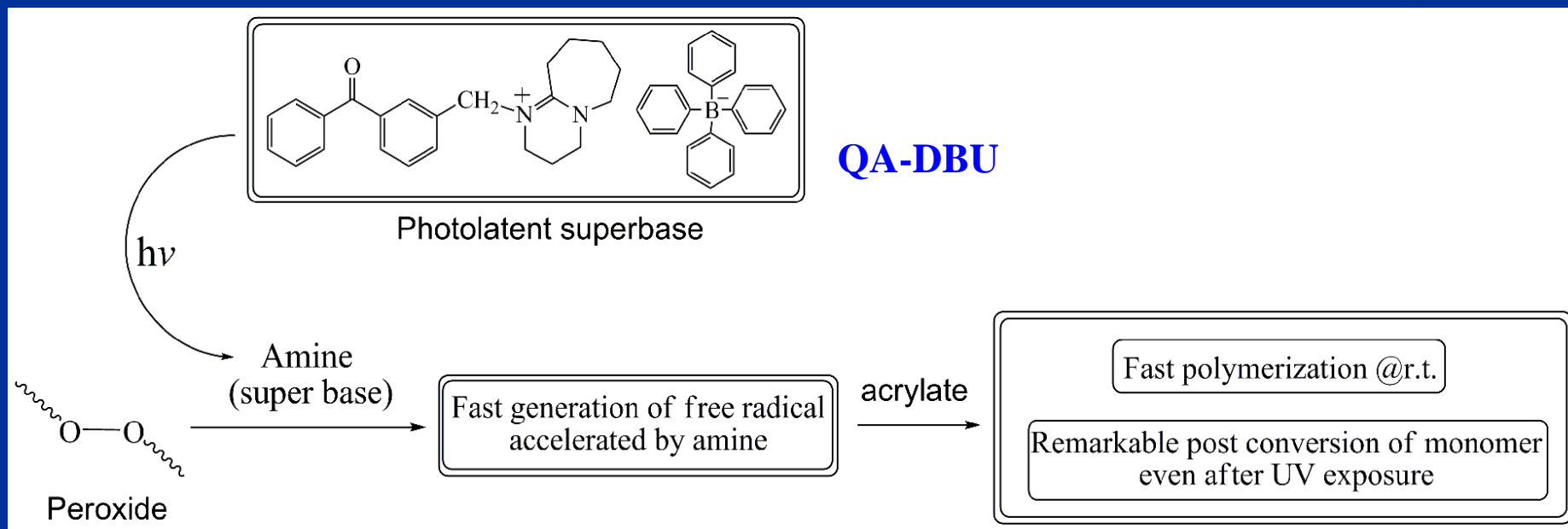
中山大學  
SUN YAT-SEN UNIVERSITY



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## Domino UV-curing





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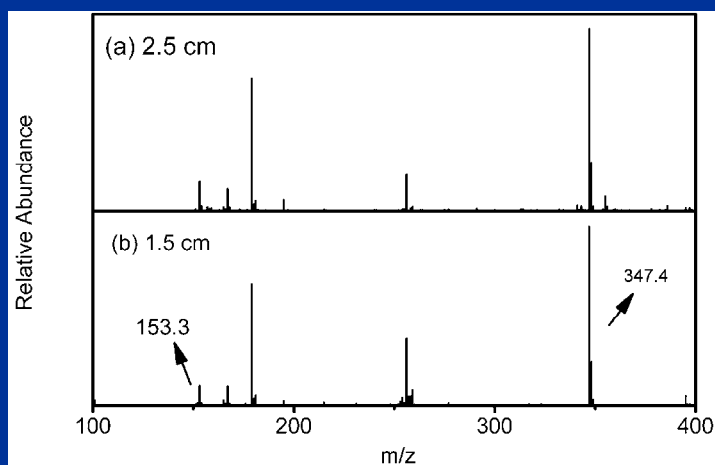
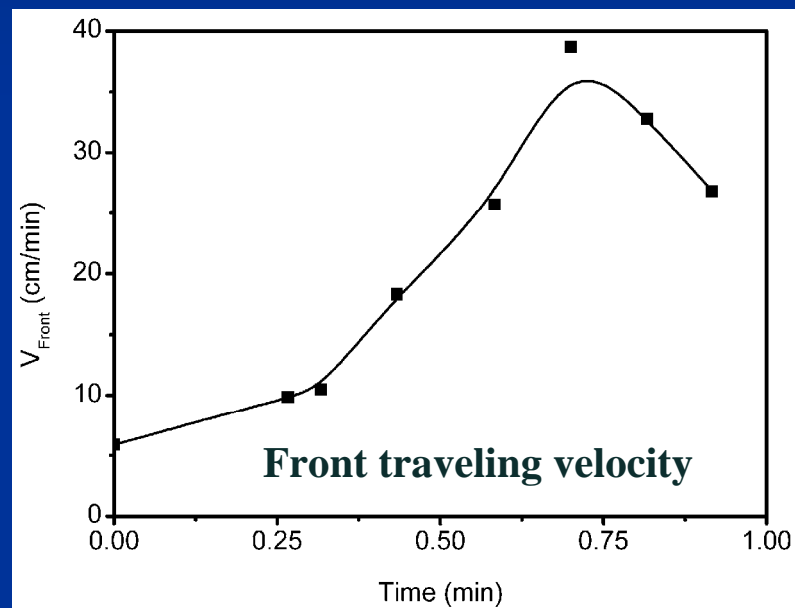
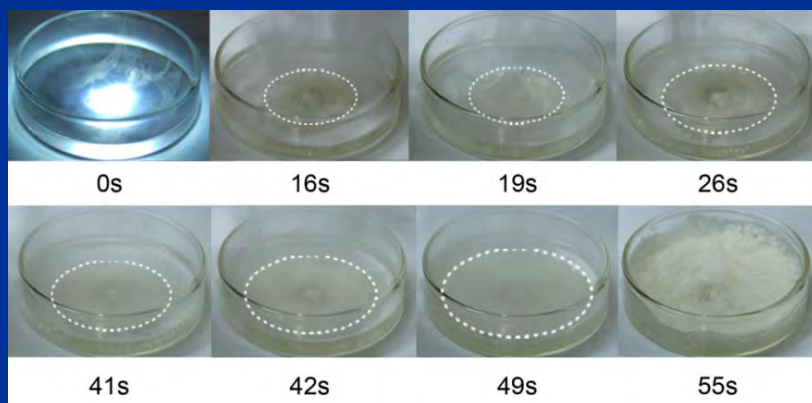
## Physical Domino curing

Monomer: TMPTA

QA-DBU + BPO

UV irradiation for 21sec

0.9 min needed for front reaching the frame

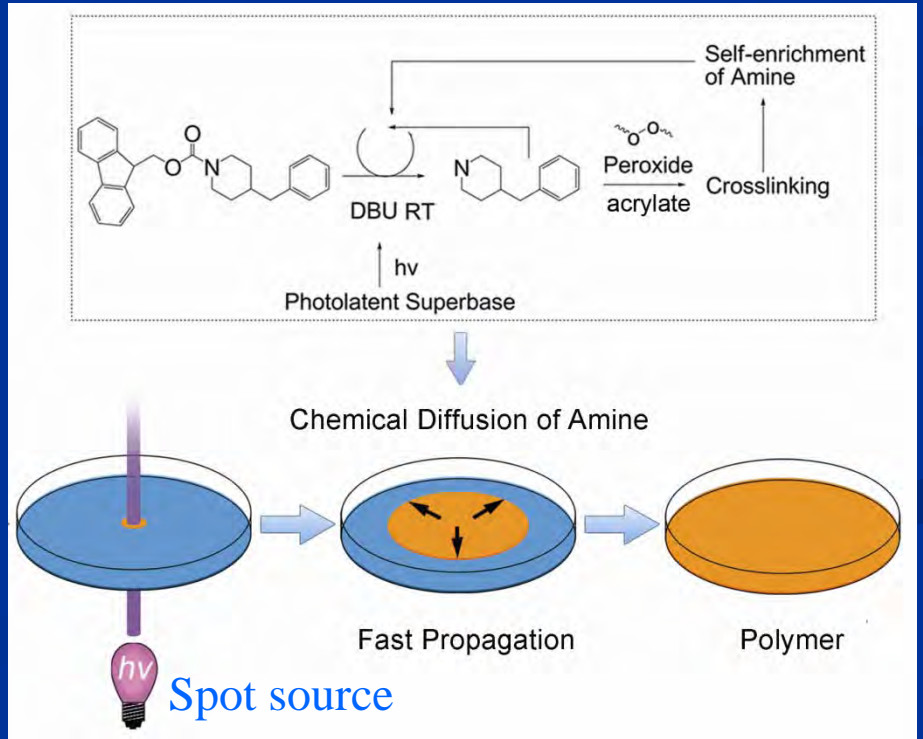
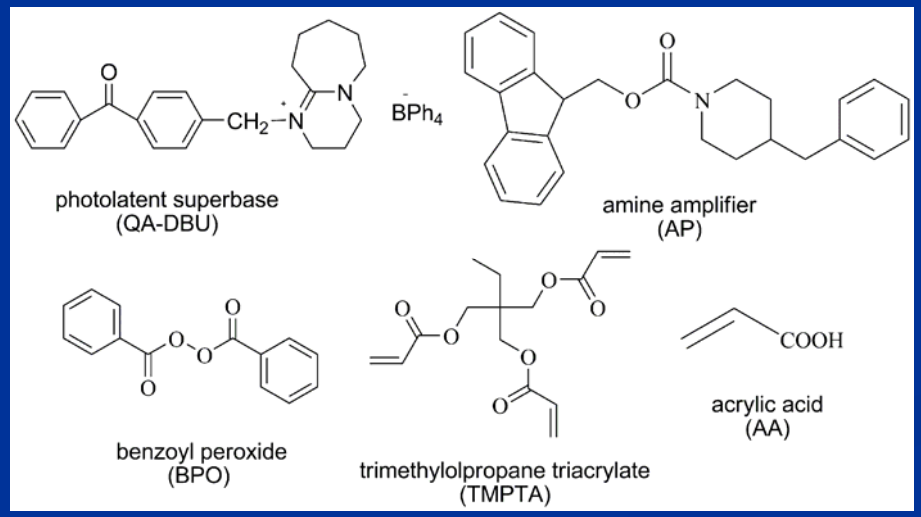
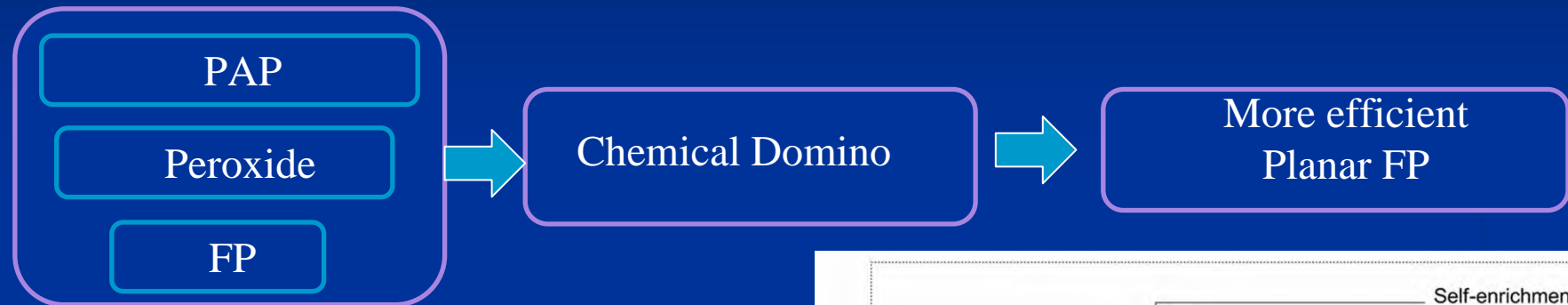


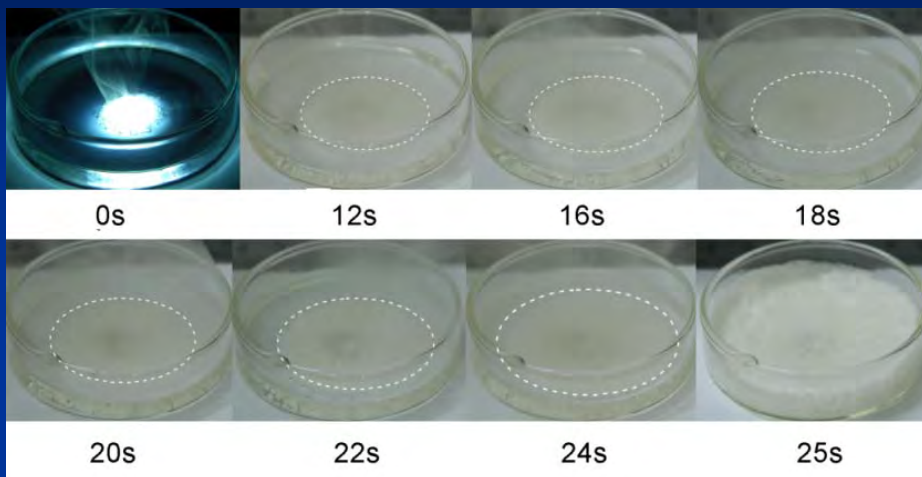
**DBU checked at different radius: (a) 2.5 cm, (b) 1.5 cm**





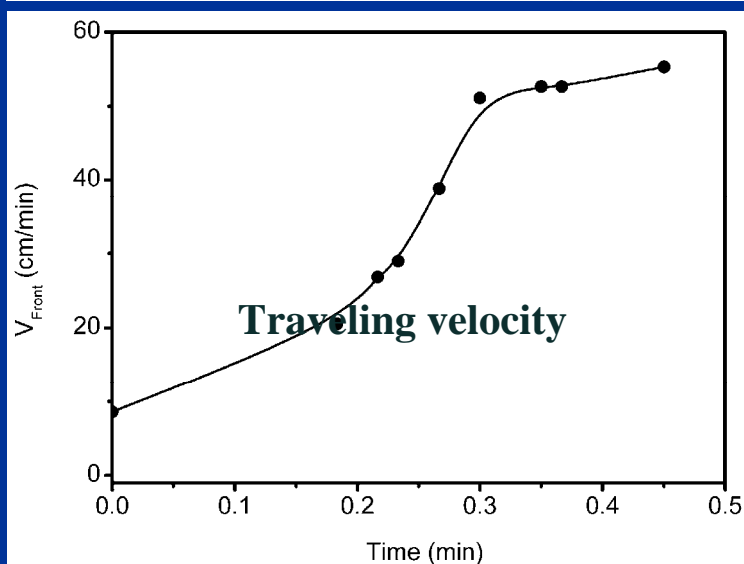
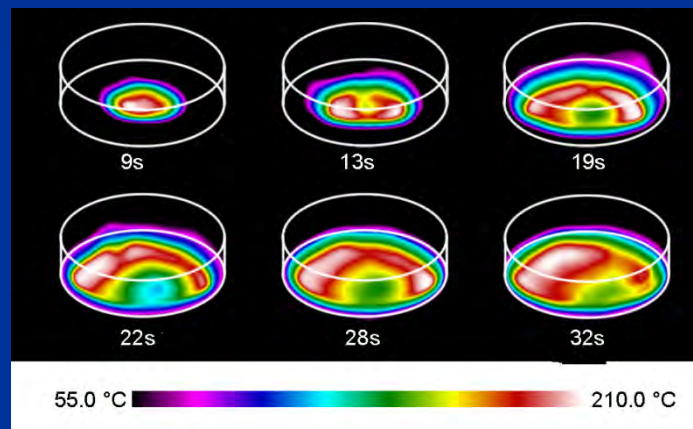
### Chemical Domino curing



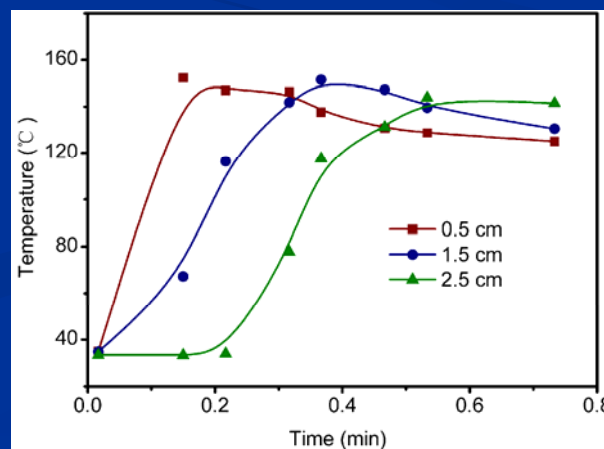


Monomer: TMPTA  
QA-DBU + BPO + AP

UV irradiation for 12 sec  
0.45 min needed for front reaching the frame



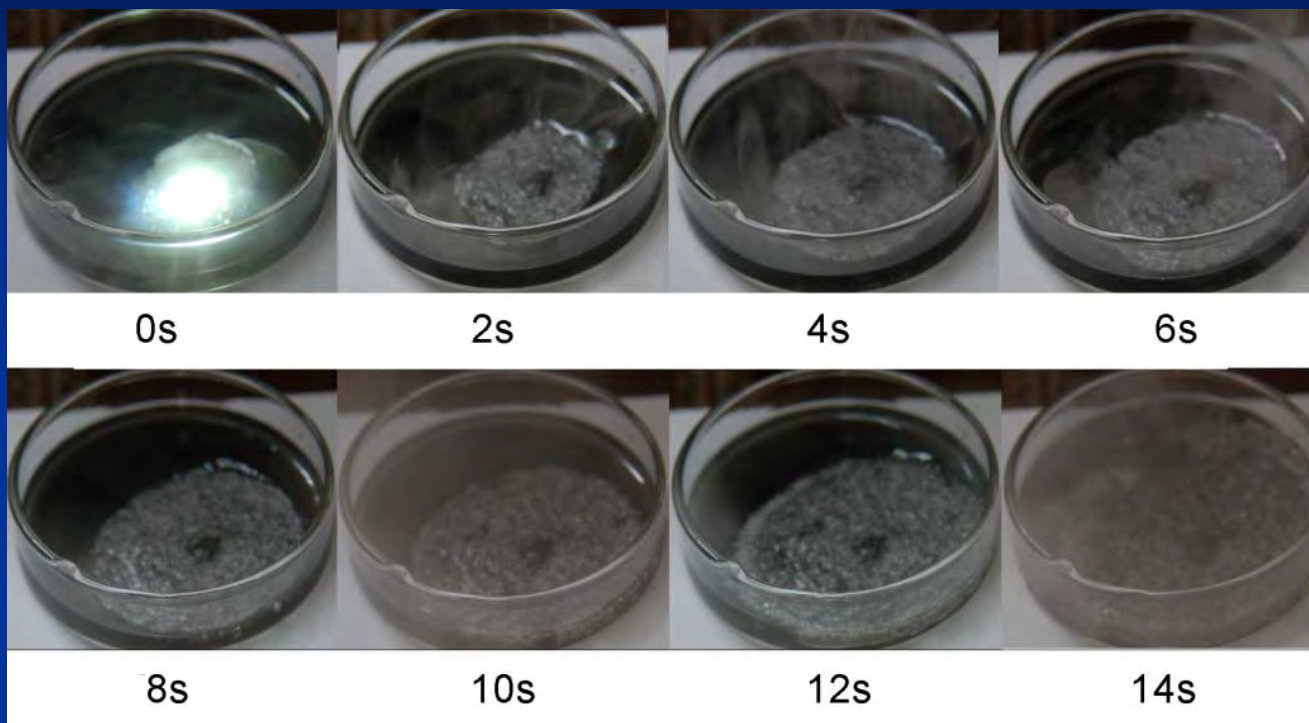
Traveling faster than the physical Domino curing





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**Carbon nano-tube pigmented formulation**

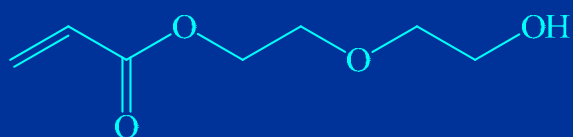
**Monomer: TMPTA**

**QA-DBU + BPO + AP**

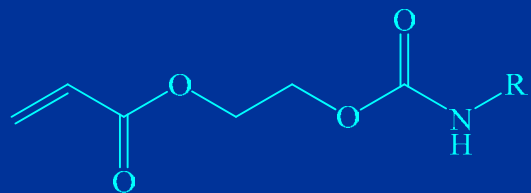
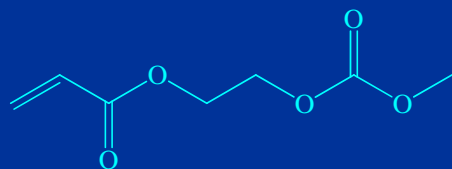
He, Minghui; Huang, Xun; Zeng, Zhaohua; **Yang, Jianwen\***, Phototriggered Base Proliferation: A Highly Efficient Domino Reaction for Creating Functionally Photo-Screened Materials, *Macromolecules* 2013, 46(16): 6402-6407



## Monomer development



Used in water-borne UV coating

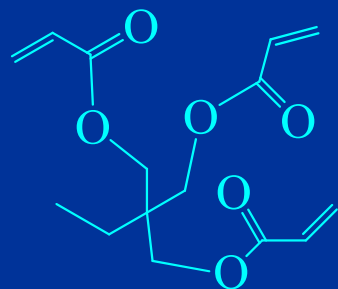
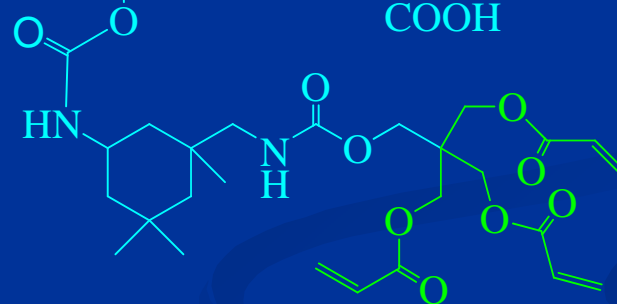




## Oligomer development



**FEVE-urethane-acrylate**



TMPTA

coupling reaction



UV Oligomer  
Low viscosity



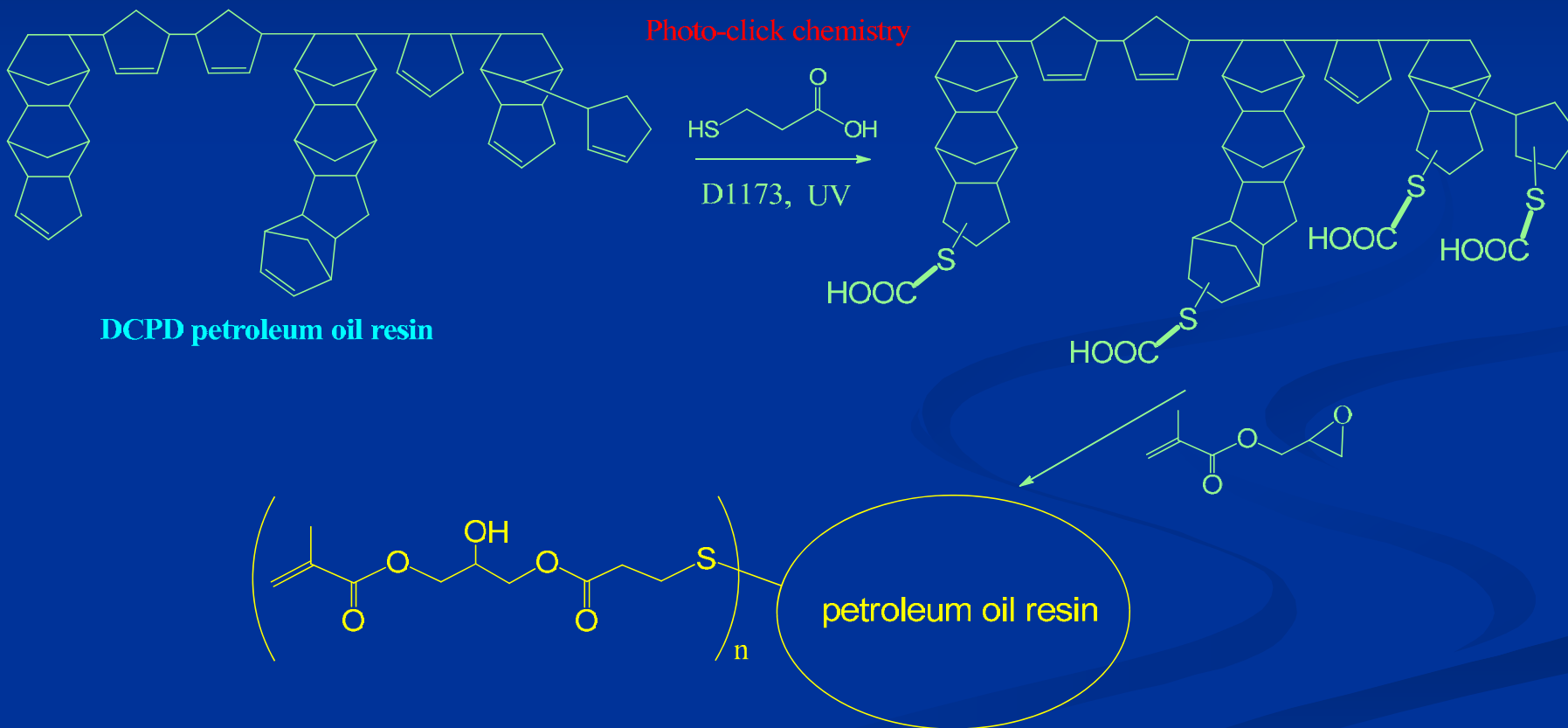
## Low price UV oligomer

appeared in China market in the past few years

- Based on epichlorohydrin, UPE...
- Mono-acrylate or multi-acrylate
- No waste water involved
  
- **1.6 USD/kg !!!**



## UV-Curable petroleum oil resin via photo-click chemistry





- UV Products Manufacture
- Advances of Materials & Technology
- **New Trends of UV-curing Applications**
- VOC Law

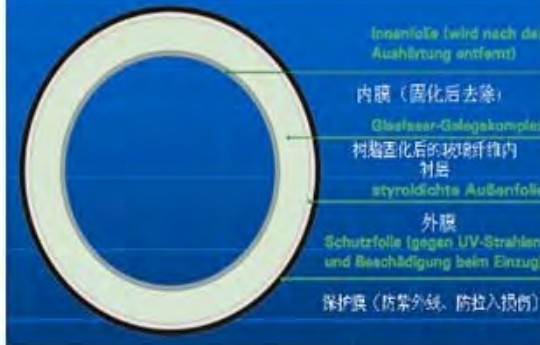
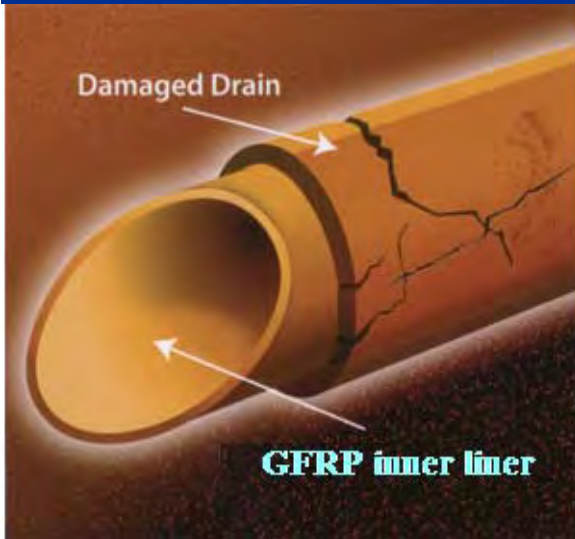




# 1) UV-Curable GFRP

UV CIPP applied in China

UV CIPP rehabilitation



GFRP inside liner

City drainage pipe line repair

Oil-gas pipe line repair



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Before repair



After repair



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## UV CIPP in Hangzhou



## UV CIPP in Quanzhou



## UV CIPP in Guangzhou





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Cities have tried UV CIPP technology

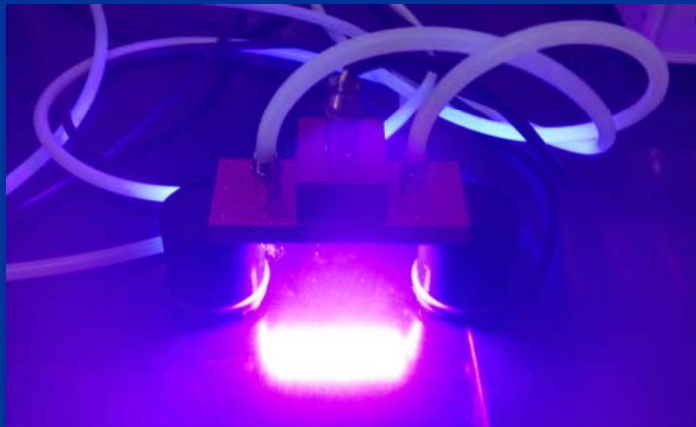
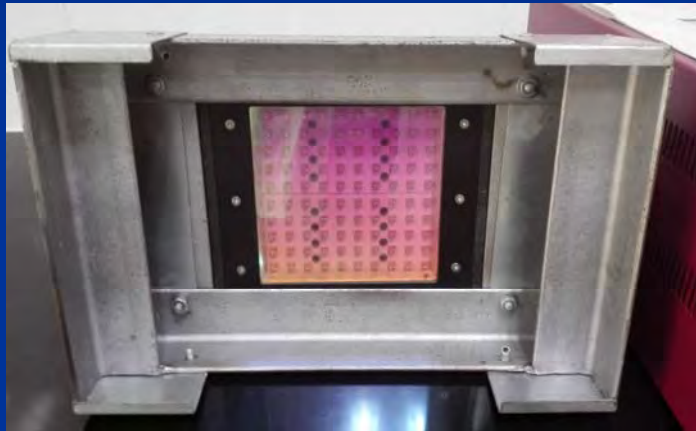


Most of the soft pipeline and equipments are imported from Germ., USA...



## 2) UV LED Curing

Most of UV LED chips imported from oversea, Japan...



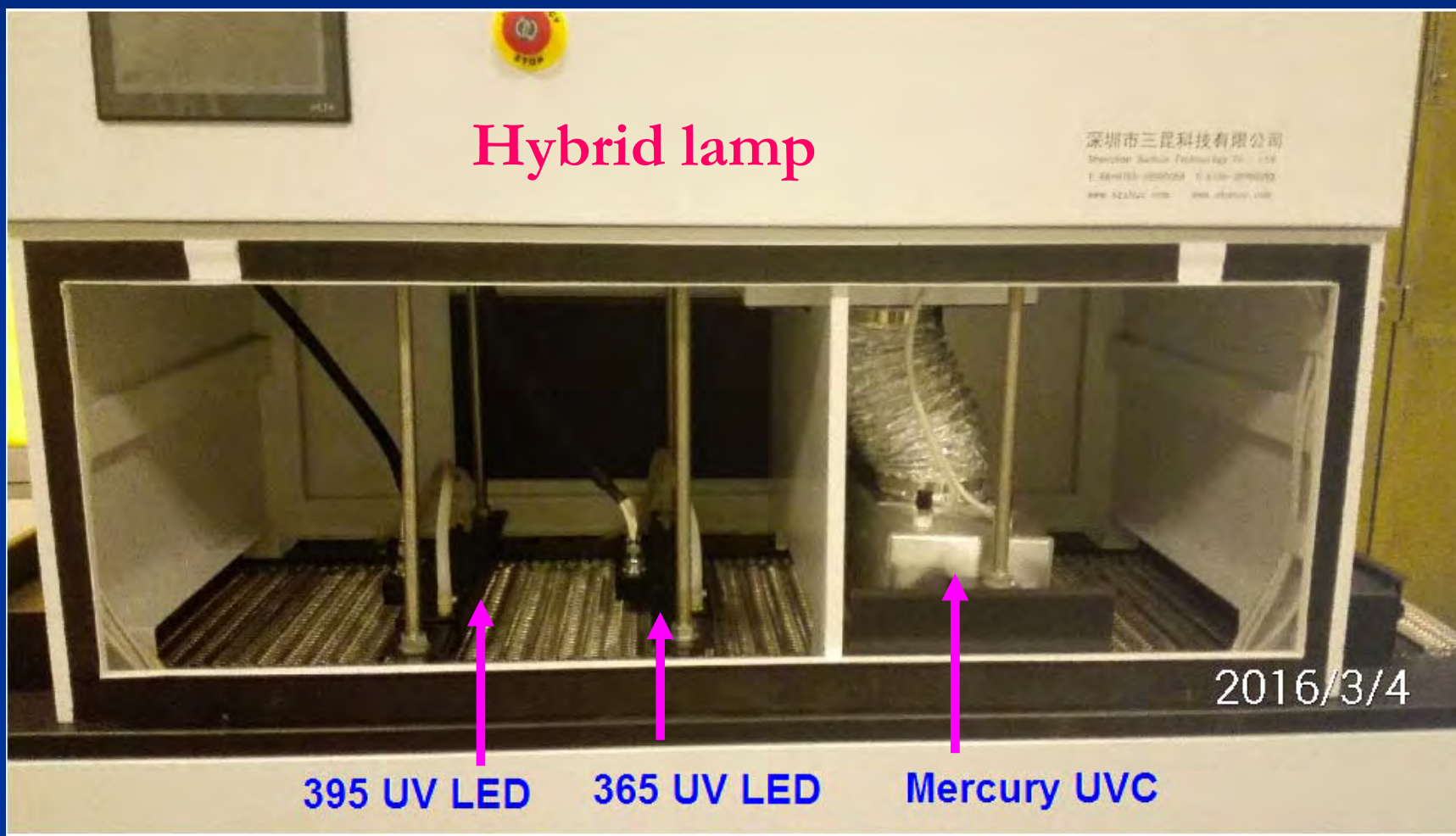


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## Hybrid lamp

深圳市三昆科技有限公司  
Shenzhen Sankun Technology Co., Ltd.  
T: 86-0755-26502024 F: 86-0755-26502023  
www.szkun.com www.stkuv.com



395 UV LED

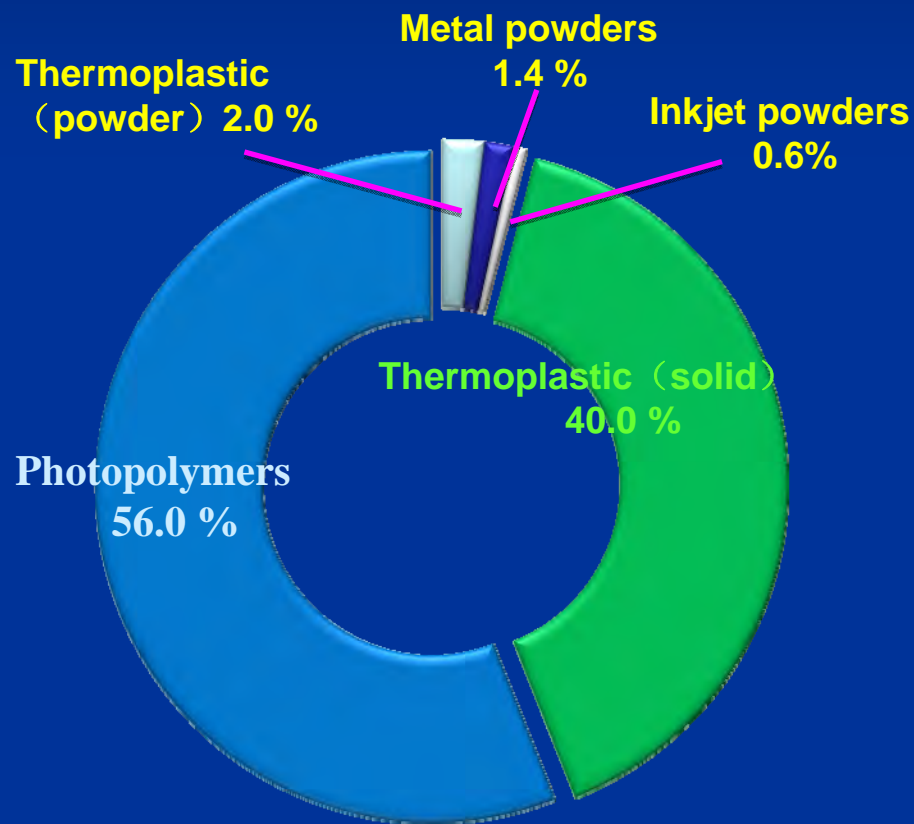
365 UV LED

Mercury UVC

2016/3/4

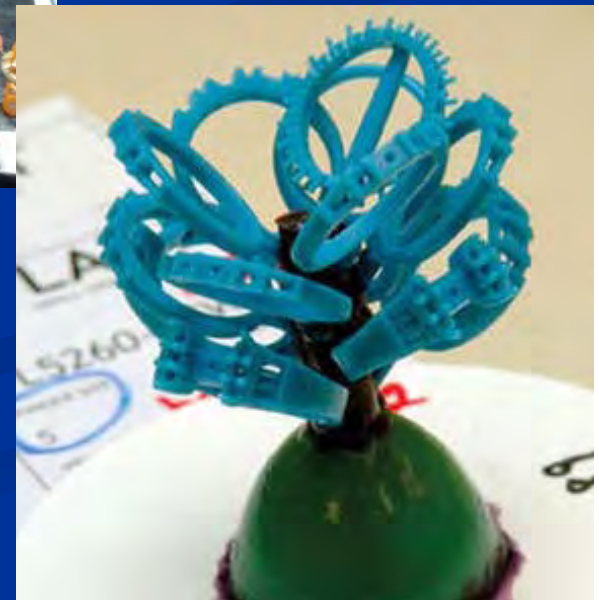


### 3) UV-Curing 3D Printing



Marketing sales (USD) percentage of printing supplies in 3D printing, IDTechex 2014

### DLP





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## SLA printer made in China



Printing teeth mode

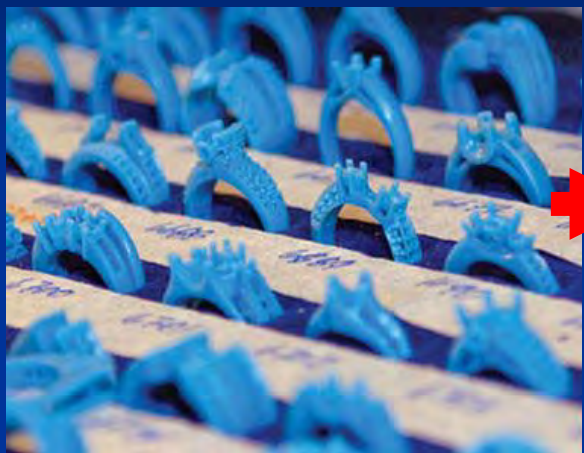




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## Fabrication of vanishing mode





## 4) Photoresist

### Semiconductor Photoresist Producer in China

<b>Company</b>	<b>Products</b>	<b>Capacity</b>
Suzhou Ruihong Electronic Chemical Co., Ltd	TFT photoresist, 193 nm ULSI	200 t/a
BKempur Microelectronics Inc.	g-line and i-line photoresist	100 t/a
Beijing Hengye Zhongyuan Chemical Co.,Ltd.	Low grade negative photoresist	Small scale
Institute of Wuxi Chemical Engineering	EB and X-ray photoresist	Small scale
Jiangyin Jianghua Microelectronic Materials Co., Ltd		Small scale
ShenZhen RongDa Photosensitive Science & Technology Co., Ltd.	LCD positive photoresist	-



## Semiconductor Photoresist R&D of China

Tech.	Year	2015	2016	2017	2018	2019	2020
KrF		Production Pilot	Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D
ArF		Lab R&D	Lab R&D	Lab R&D	Production Pilot	Production Pilot	Production Pilot
ArFi		Lab R&D	Lab R&D	Lab R&D	Lab R&D	Production Pilot	Production Pilot
EUV		Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D
DSA		Lab R&D	Lab R&D	Production Pilot	Production Pilot	Lab R&D	Lab R&D
Ebeam		Lab R&D	Lab R&D	Production Pilot	Production Pilot	Lab R&D	Lab R&D
KrF BARC		Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D
ArF BARC		Lab R&D	Lab R&D	Lab R&D	Production Pilot	Production Pilot	Production Pilot
Positive photoresist Potting		Production Pilot	Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D
Negative photoresist Potting		Production Pilot	Lab R&D	Lab R&D	Lab R&D	Lab R&D	Lab R&D

Lab R&D

Lab Pilot

Production Pilot

Production

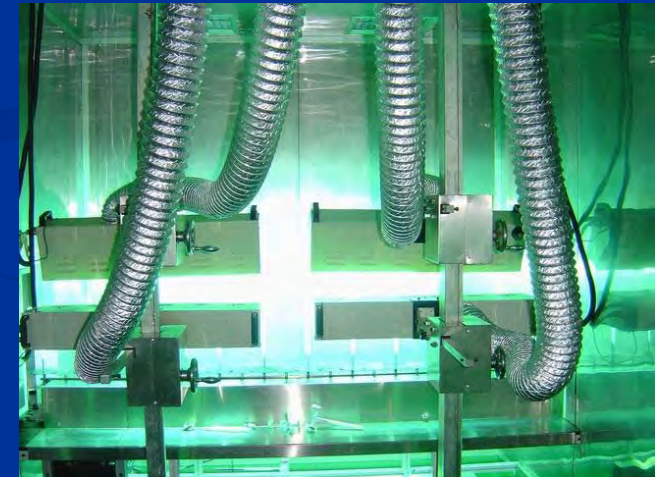


## 5) Non-solvent Sprayable Coating

**Monomer:** monofunctional, high reactive, low viscosity

**Oligomer:** multi-acrylate, low viscosity, high reactive

Applied in wood decoration





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Coating VOC Tax Code Issued by

Ministry of Finance of PRC and State Administration of Taxation

- From Oct 1, 2015
- VOC content > 420 g/kg (heated for 1 hr @ 250°C)
- 4% tax ratio imposed

There are many local codes issued for limiting VOC

Beijing, Shenzhen, Jiangsu...



## On-line VOC Detection System established in China





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**Thank you**

**Jianwen YANG**

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**Email: [cesyjw@mail.sysu.edu.cn](mailto:cesyjw@mail.sysu.edu.cn)**