Photobonding^{TM} Technology

USHIO Inc.
Bryn Gornick
Application Engineer, Scientific Medical Division
Ushio America Inc.
June 28th, 2017

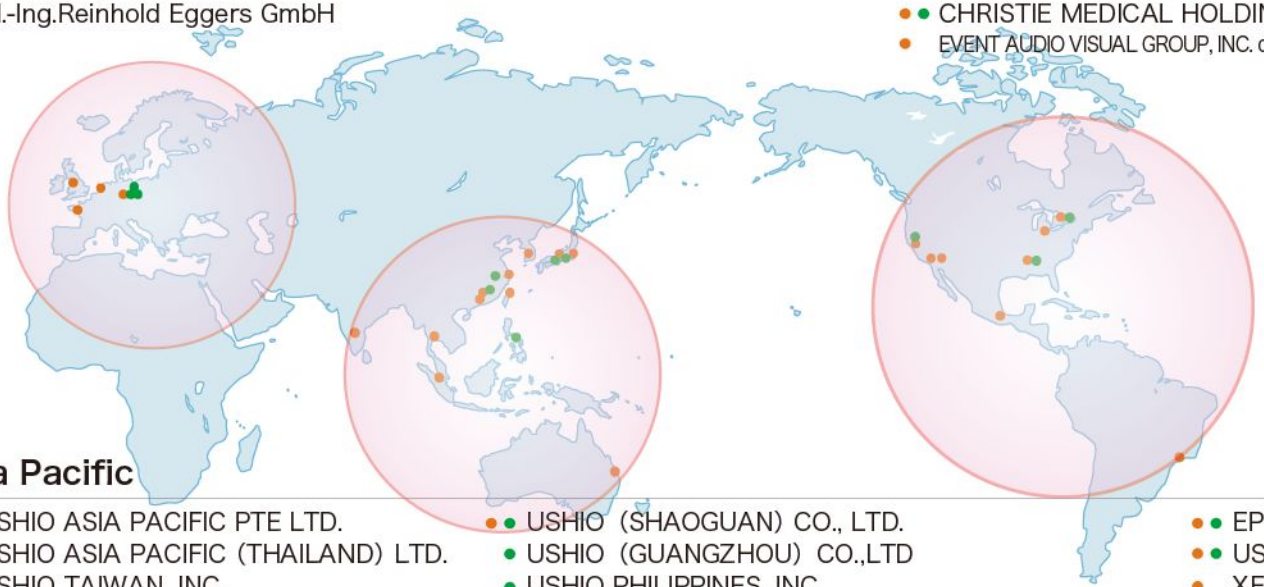
<USHIO Group around the world>

Europe

- USHIO EUROPE B.V.
- USHIO FRANCE S.A.R.L.
- USHIO DEUTSCHLAND GmbH
- USHIO U.K., LTD.
- BLV Licht - und Vakuumtechnik GmbH
- NATRIUM Sp. zo.o.
- Dipl.-Ing.Reinhold Eggers GmbH

Americas

- USHIO AMERICA, INC.
- NECSEL INTELLECTUAL PROPERTY, INC.
- CHRISTIE DIGITAL SYSTEMS USA, INC.
- CHRISTIE DIGITAL SYSTEMS CANADA INC.
- CHRISTIE DIGITAL SYSTEMS MEXICO S.de R.L.de C.V.
- CHRISTIE DIGITAL SYSTEMS SOUTH AMERICA LTDA.
- CHRISTIE MEDICAL HOLDINGS, INC.
- EVENT AUDIO VISUAL GROUP, INC. d.b.a. NATIONWIDE WHOLESALE VIDEO INC.



Sales
Production

Asia Pacific

- USHIO ASIA PACIFIC PTE LTD.
- USHIO ASIA PACIFIC (THAILAND) LTD.
- USHIO TAIWAN, INC.
- USHIO KOREA, INC.
- USHIO HONG KONG LTD.
- USHIO SHANGHAI, INC.
- USHIO SHENZHEN, INC.
- USHIO (SUZHOU) CO., LTD.
- USHIO (SHAOGUAN) CO., LTD.
- USHIO (GUANGZHOU) CO.,LTD
- USHIO PHILIPPINES, INC.
- CHRISTIE DIGITAL SYSTEMS (SHANGHAI) LTD.
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- EPITEX INC.
- USHIO LIGHTING, INC.
- XEBEX INC.
- NIHON DENSHI GIJUTSU CO., LTD.
- ADTEC Engineering Co., Ltd.
- PROTOSERA INC.
- USHIO OPTO SEMICONDUCTORS, INC.
- MAXRAY INC.

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- EXCIMER LAMP -

Excimer Lamp Characteristics

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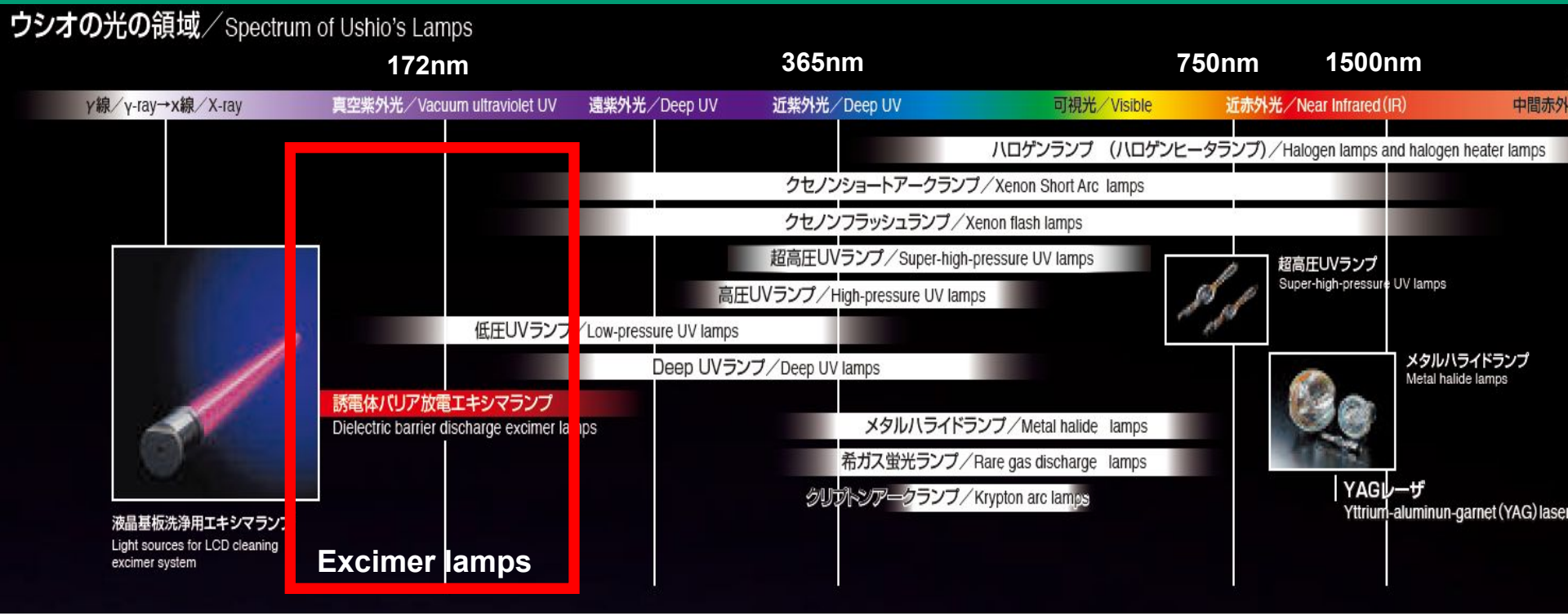
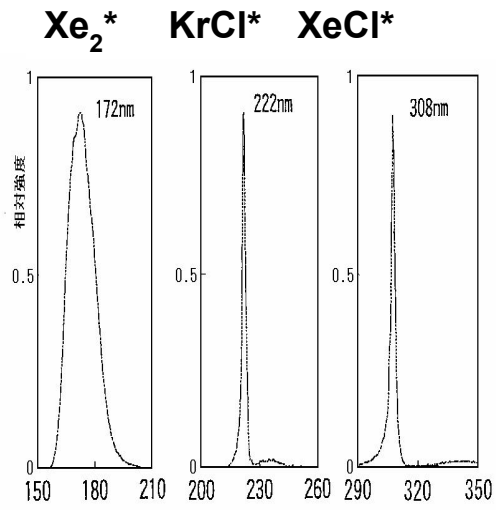
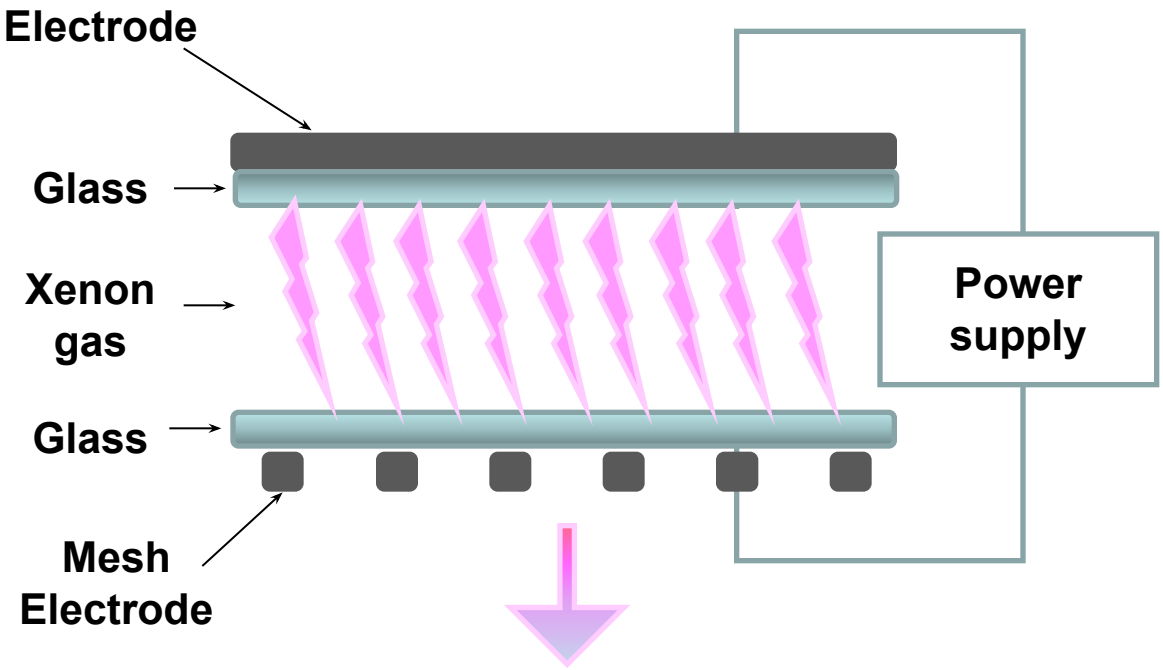


1. Short wavelength
2. High efficiency
3. Low heat generation
4. Instant ignition
5. Lamp installation in arbitral direction
6. Mercury free

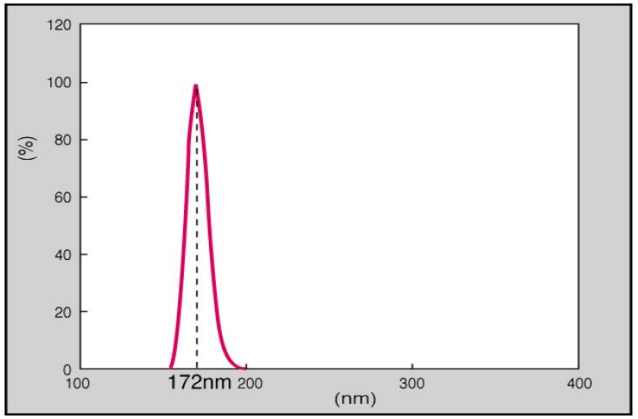


Xe_2 Excimer lamp

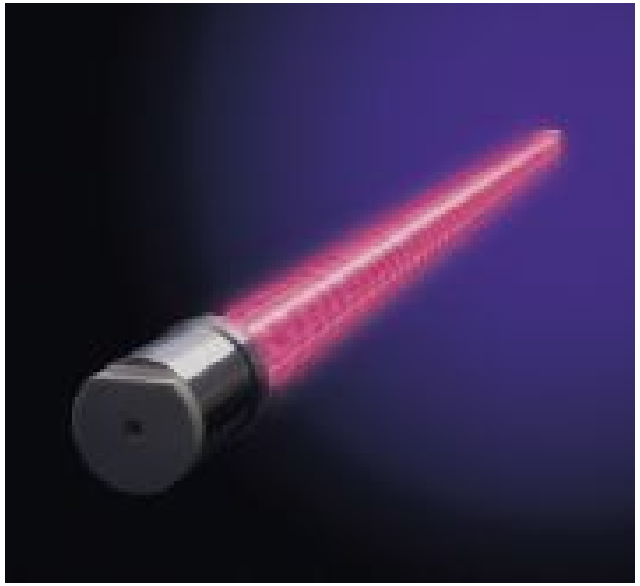


Vacuum ultra-violet

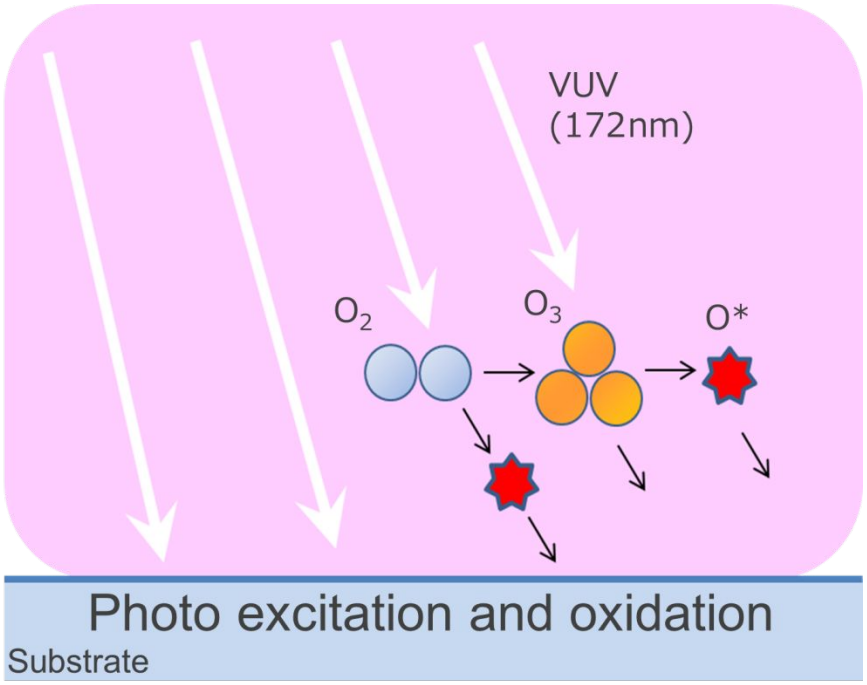
172nm

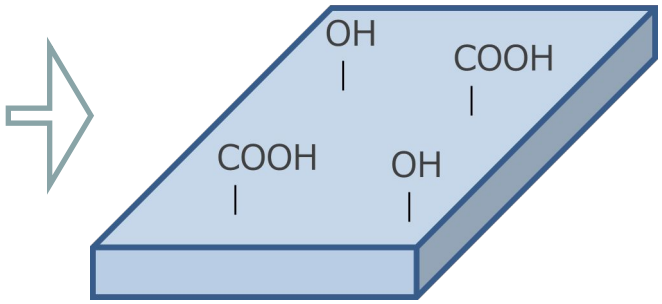


Spectrum of Xe_2 excimer lamp



Surface Activation by Xe_2 Excimer Lamps





Photon Energy of 172-nm VUV Light

166.7 kcal/mol

Bonding Energy of Various Molecular Structures

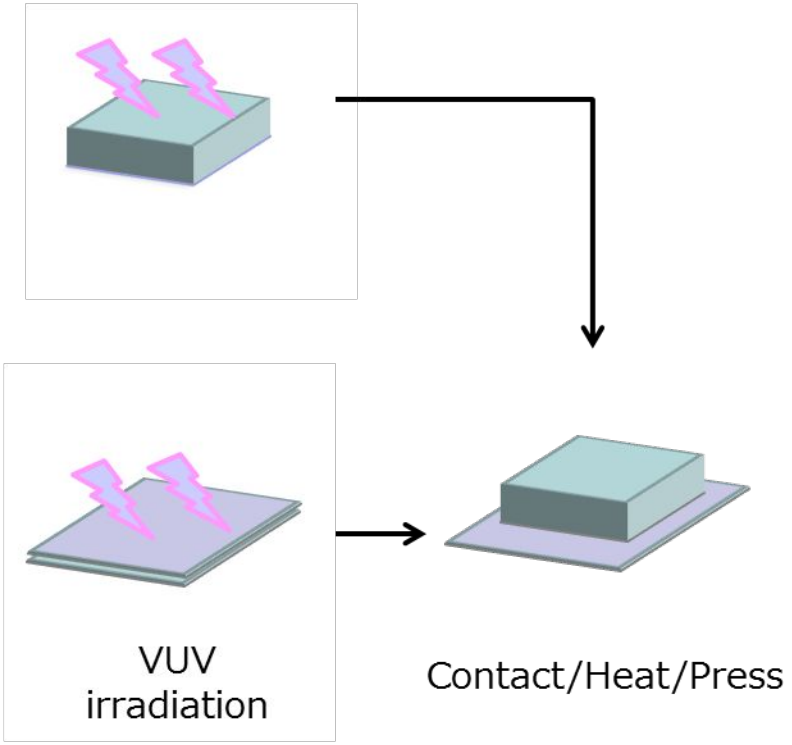
C—C	84.3kcal/mol
C═C	140.5
C—H	97.6
C—F	115.2
C—Cl	76.9
C—N	63.6
C—O	76.4
C═O	190.0
O—O	32.9
O═O	117.5
O—H	109.3
H—F	134.9
H—Cl	101.9
N—H	91.9
Si—O	150.0

- PHOTOBONDING™ -

(DIRECT BONDING)

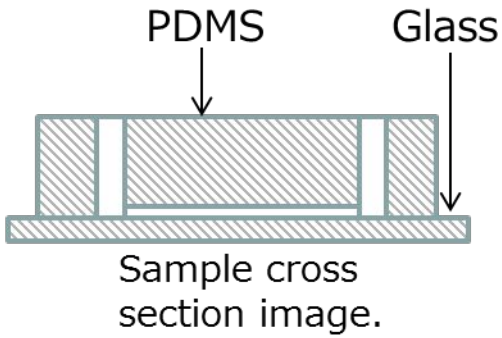
Bonding Process and Application

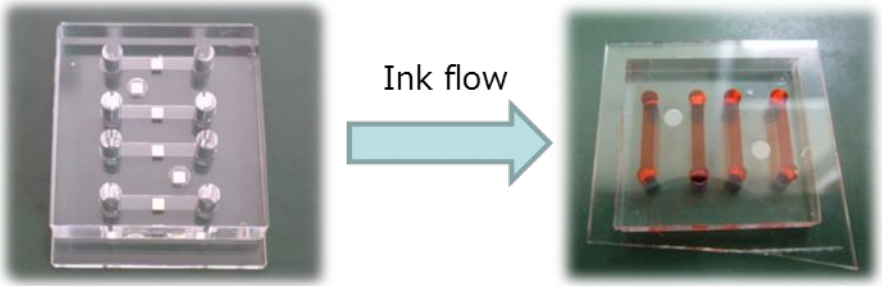
Bonding process



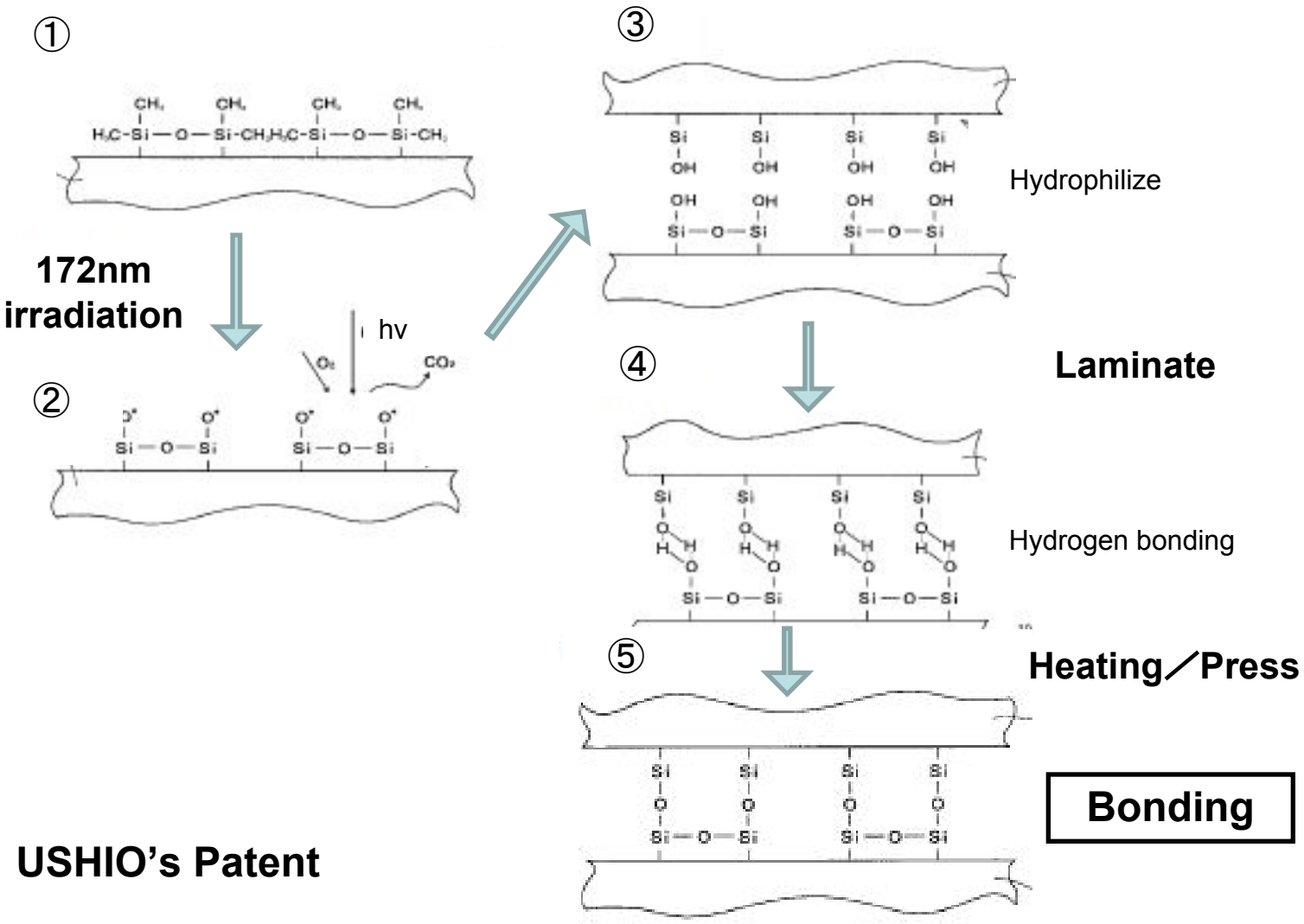
Example

Microfluidic device





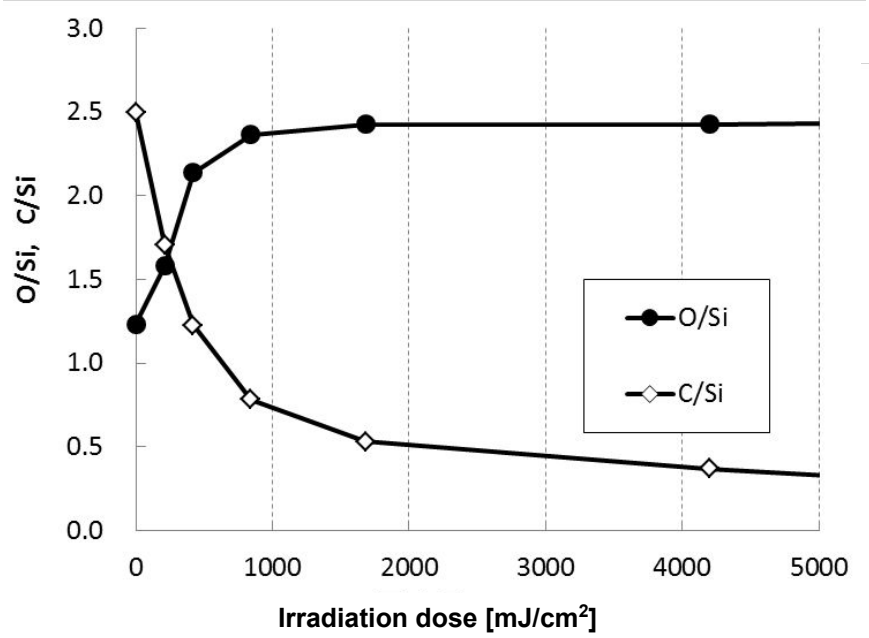
Bonding Mechanism (PDMS / Glass)

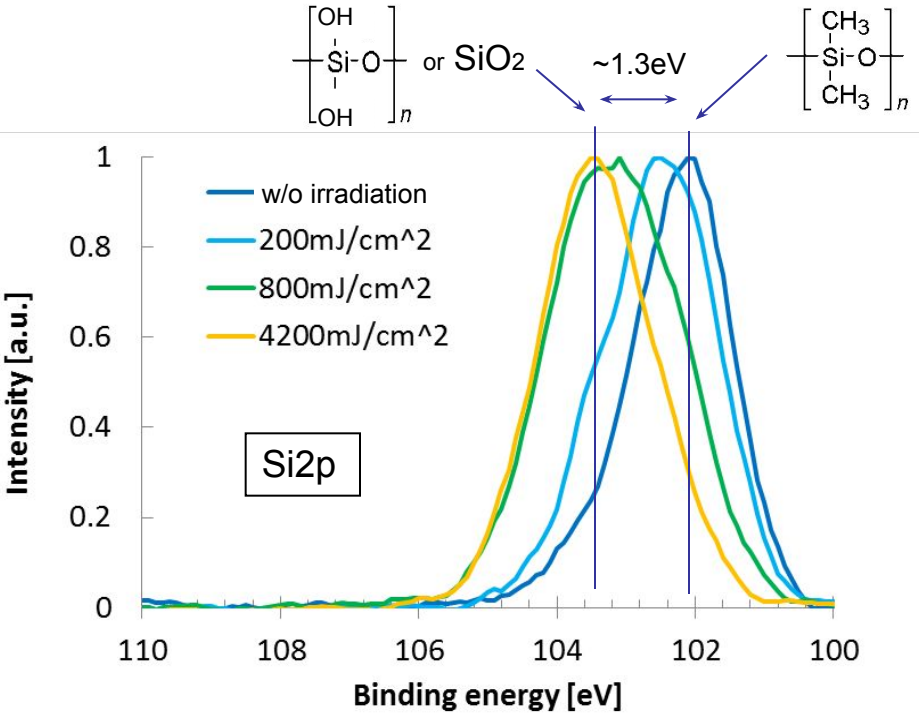


USHIO's Patent

XPS Analysis of VUV Activated Surface of PDMS

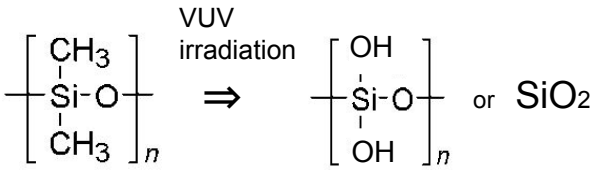
PDMS (Polydimethyl siloxane)





✓ C/Si ratio decrease, and O/Si ratio increase

✓ Si-O bond increase



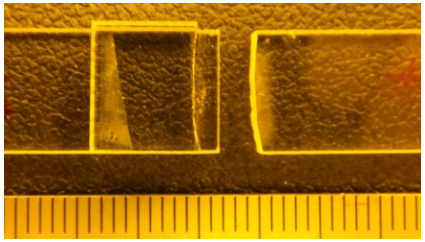
※Cooperative research with
National Institute for Materials Science

Bonding Test Results

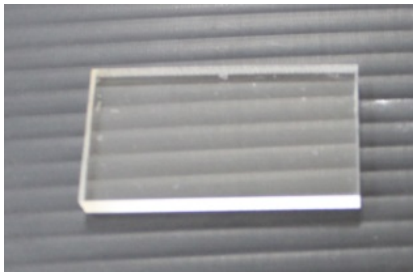
USHIO

○ : Good
△ : Limited

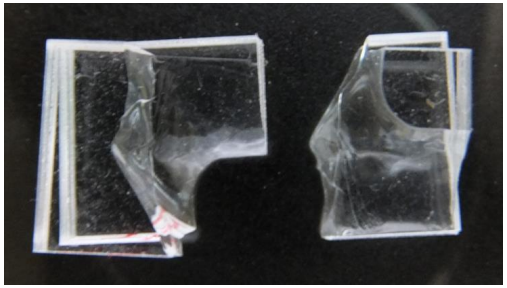
	PDMS	COP	PMMA	Quartz glass
PDMS	○			
COP	○	○		
PMMA		△	△	
Quartz glass	○		△	○



COP-COP

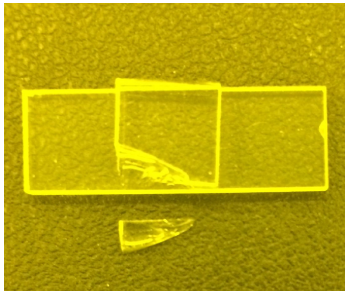


PMMA-PMMA



PDMS-PDMS

PDMS-Glass



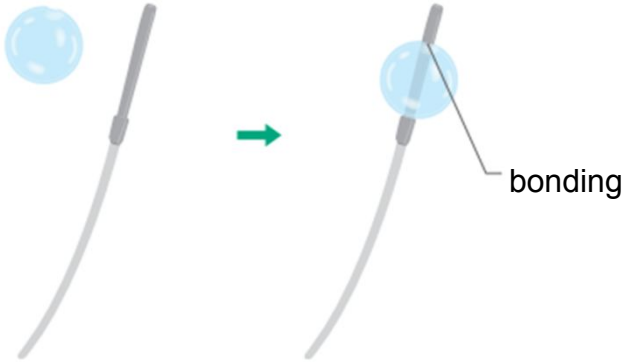
PDMS-COP

Features and Applications

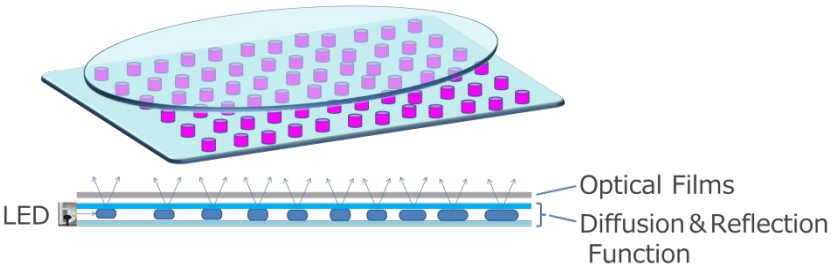
- ✓ **Adhesive free bonding**
- ✓ **Low temperature process**
- ✓ **Small deformation**

Bio chip

Medical device



Light guide



Film

End of Presentation

USHIO

Lighting — Edge Technologies