172nm准分子UV在薄膜行业应用

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准分子Excimer概念

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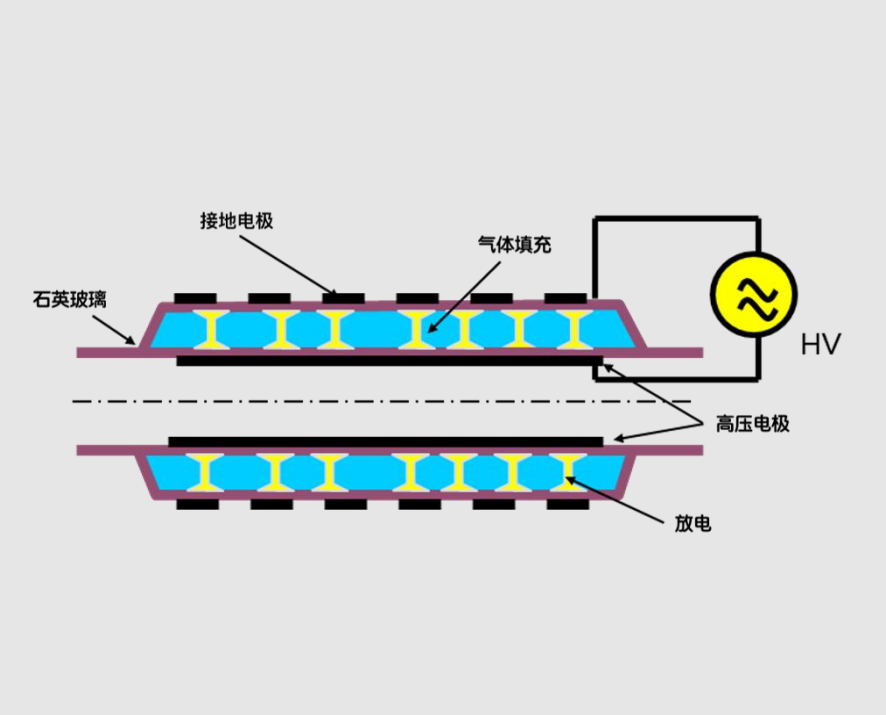
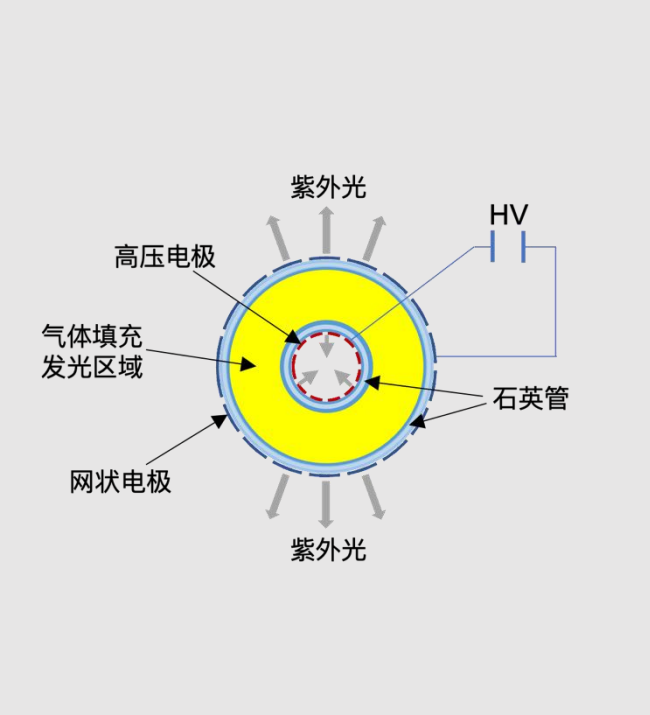
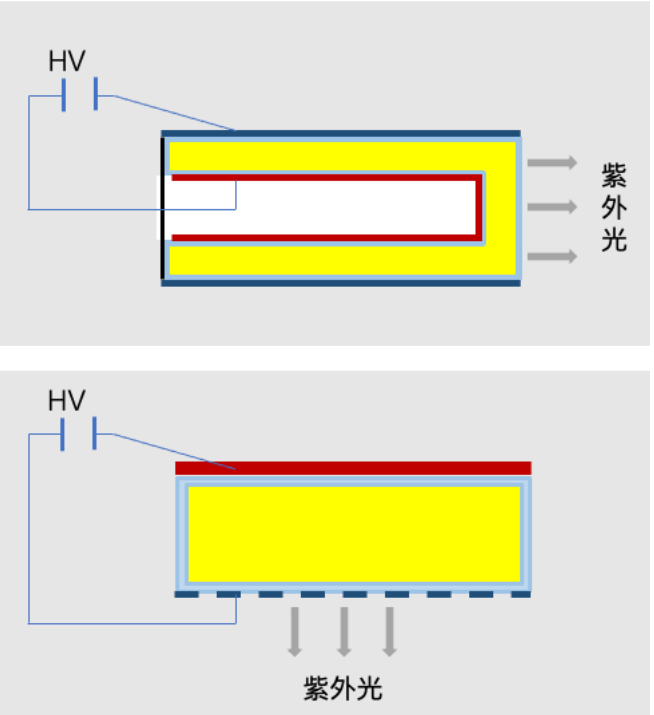
准分子Excimer = excited + dimer

激发二聚体：由两个相同或不同种类的原子或分子形成的，激发态的分子

准分子光源原理（介质阻挡放电DBD）







- 高压电极和接地极中间有二个石英绝缘层
- 石英管内填充特种气体
- 两电极间施加**高频高压电**激发

- 产生**极不稳定的瞬时存在的**激发态分子(准分子)
- 从激发态回归基态时**释放出能量**
- **辐射出特定波长的光**

准分子光源光谱

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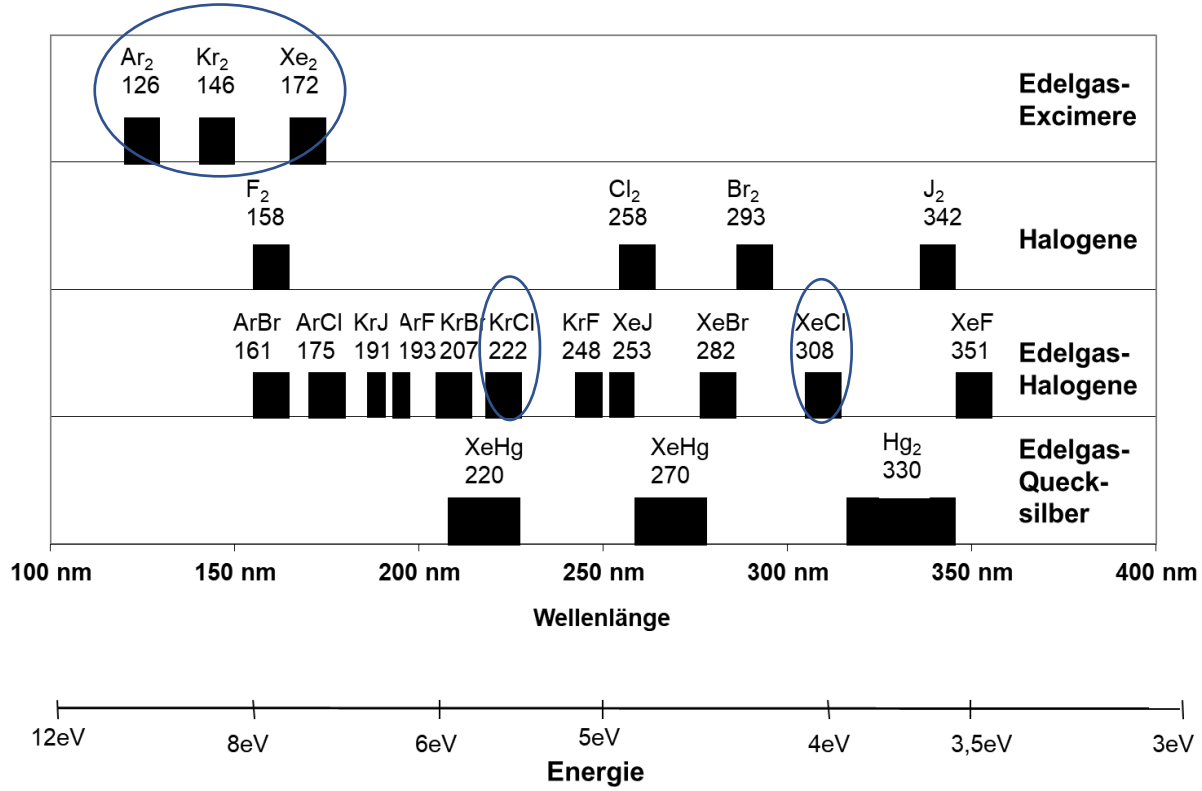
不同的准分子光源产生各种波段的辐射光谱

氙Xe_2^*	172 nm	7.2 eV
溴化氪KrBr*	207 nm	6.0 eV
氯化氪KrCl*	222 nm	5.6 eV
氯化氙XeCl*	308 nm	4.0 eV

- 207nm，222nm紫外线可用于杀菌消毒，对皮肤眼睛无伤害
  (200-230nm光线不会穿透皮肤表层)
- 308nm紫外线可用于医疗，涂料固化，光化学反应
- 最常用的是172nm波长的准分子紫外线
  （属于真空紫外线，VUV）

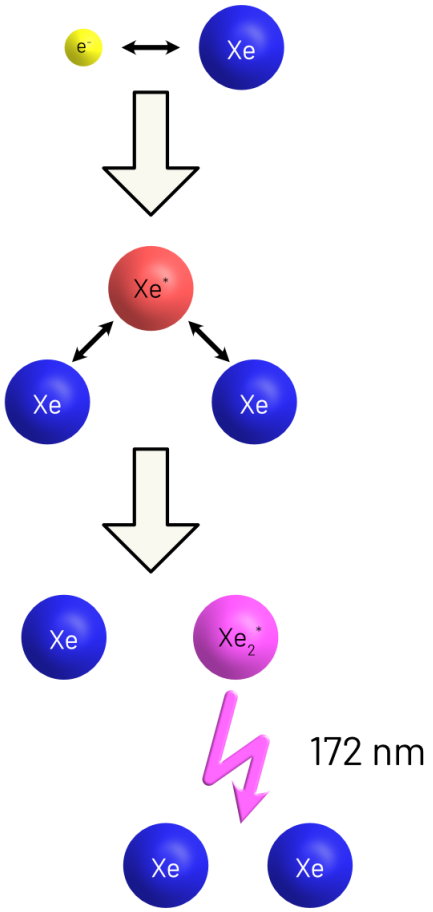


172nm准分子紫外线

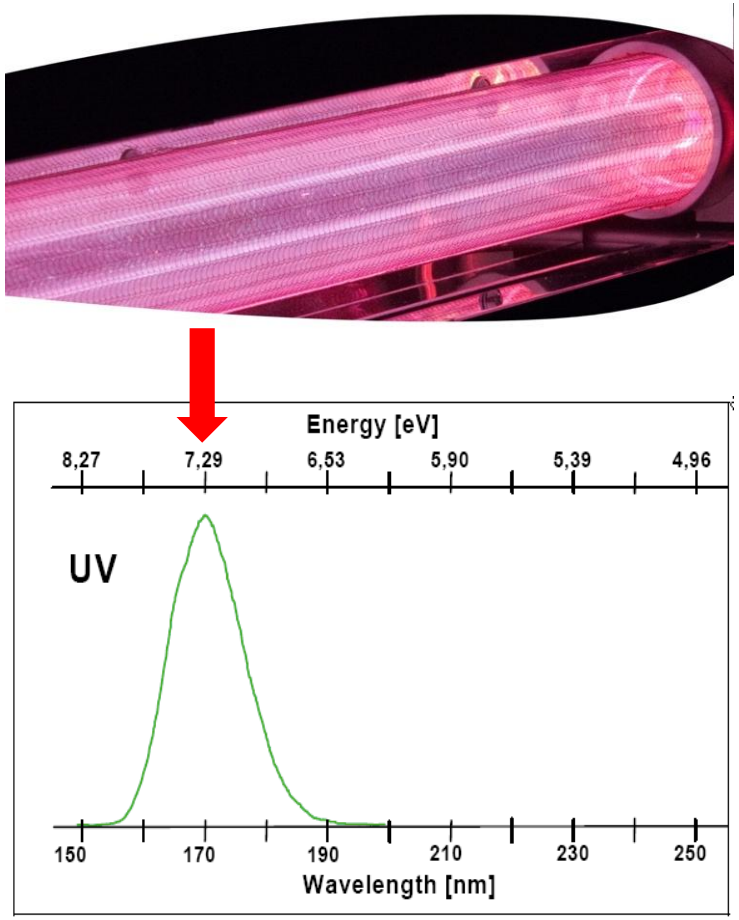
- 石英管内填充**氙气(Xe)**气体
- 辐射出**172nm真空紫外线(VUV)**

特点

- 高效光电转化率：～40%
- **极高的光子能量：7.2 eV (696kJ/mol)**
- 单色狭窄光谱，紫外光输出集中
- 波长范围：164 ~ 177 nm
- 可快速开关
- 冷光源，无红外输出
- 环保无汞



氙准分子紫外灯机理示意图



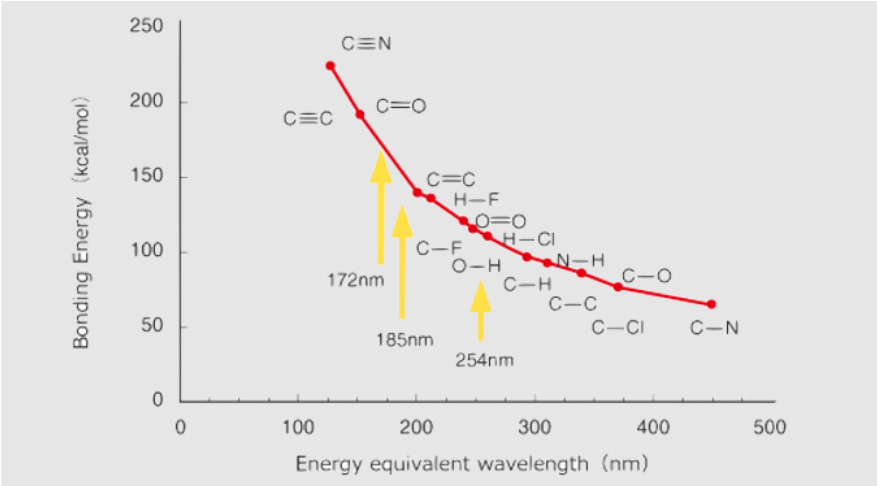
氙准分子紫外灯光谱图

172nm准分子UV特性

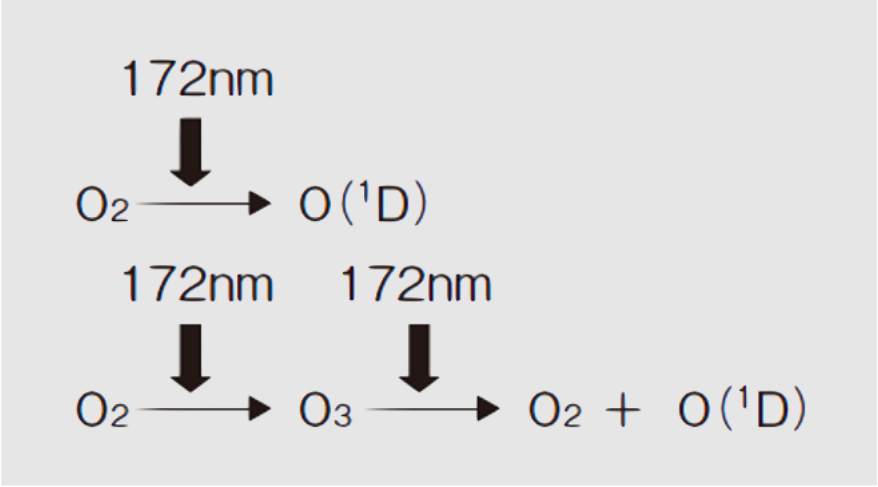
极高的光子能量：7.2 eV (166kcal/mol)

- **能切断大多数化学键**：
  - C-C单键和双键 (缩短有机分子链)
  - C-H_x键
  - H-H键
  - O-O单键和双键 (产生*臭氧*及*活性氧原子*)

- **无法切断的化学键**：
  - C-C三键
  - C-O双键 (无法分解CO_2)
  - N-N三键 (无法分解N_2，不会产生NO_x)



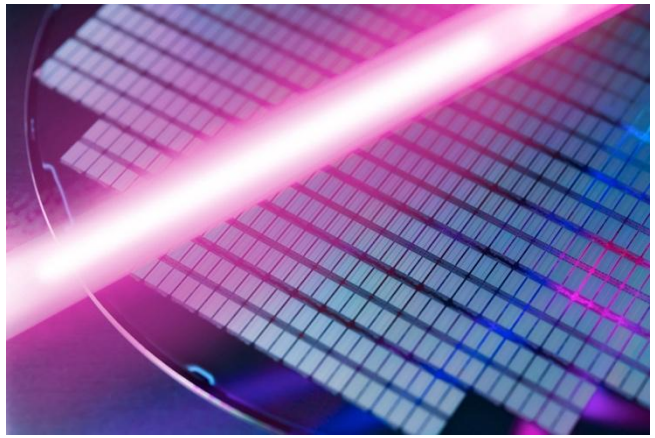
化学键能及波长图



172nm光与氧分子反应机理

应用行业 @172nm

- **表面处理**
  - 清洗
  - 改质活化
- **涂层固化**
  - 超哑光肤感
  - 表面微结构
- **光化学反应**
  - 水氧阻隔层
  - 光CVD



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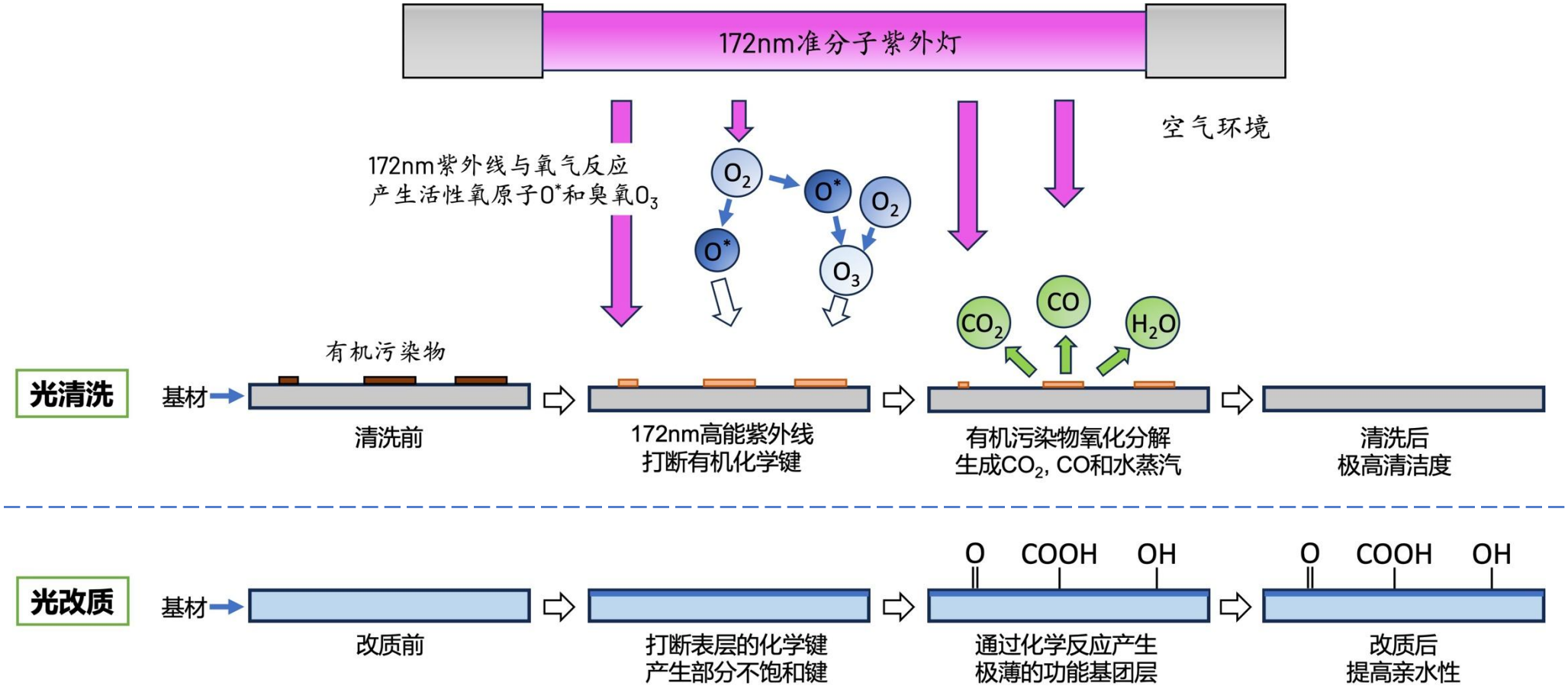
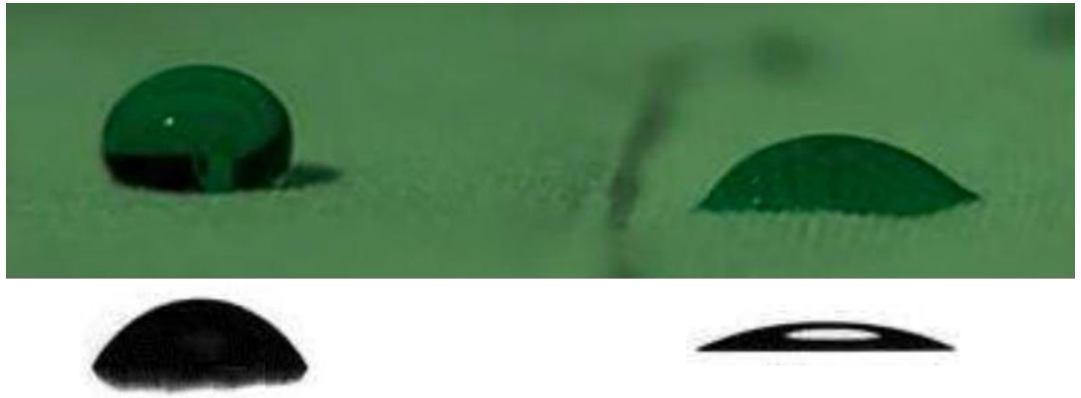
准分子UV表面处理
--清洗/改质

172nm UV光清洗/改质原理

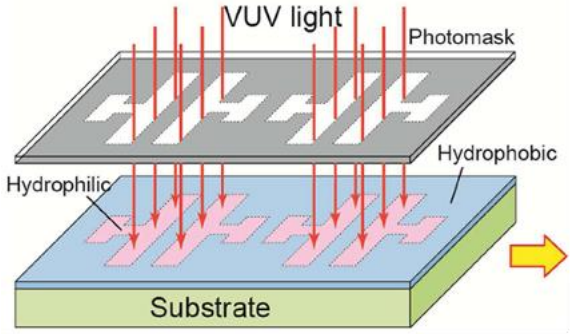


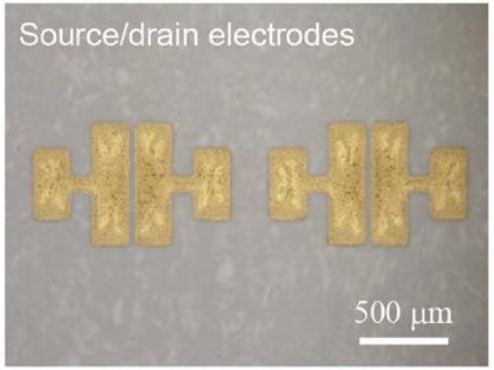
表面清洗/改质效果

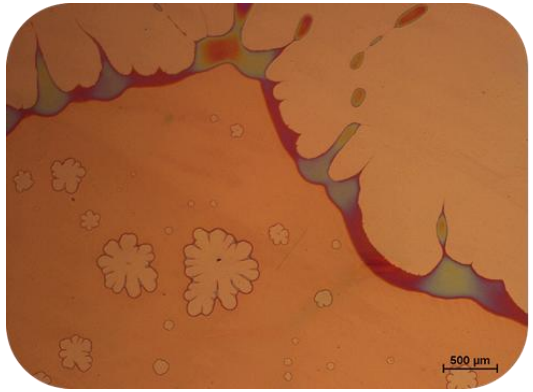
- 准分子UV可以应用于各种各样的材料，如塑料，素玻璃，ITO玻璃/薄膜，陶瓷，以及金属。



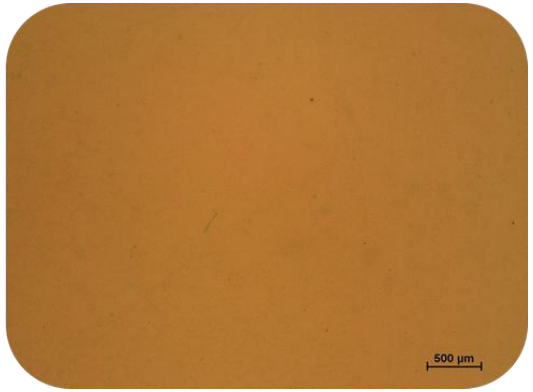
处理前　　准分子处理后



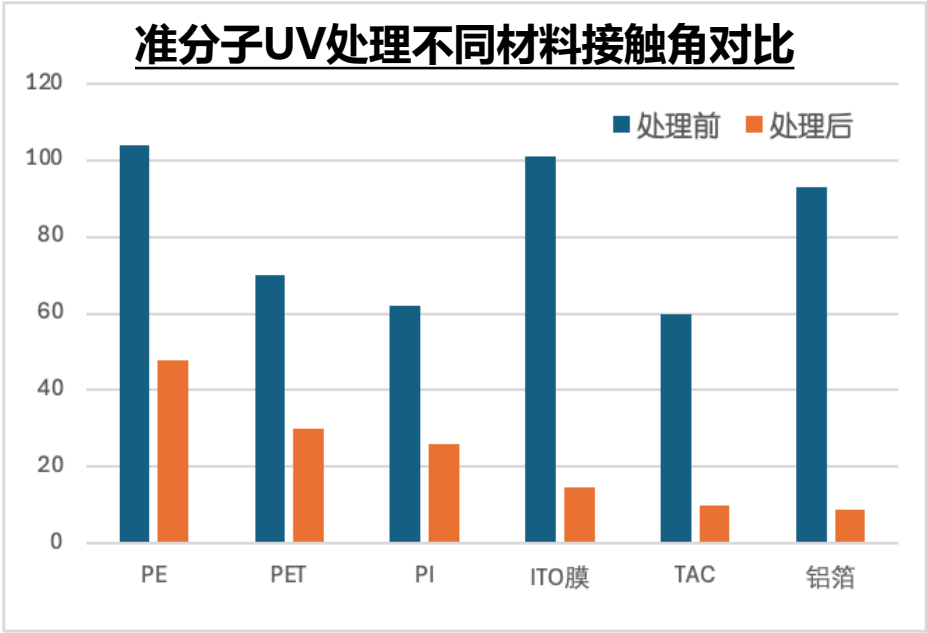




无预处理涂布

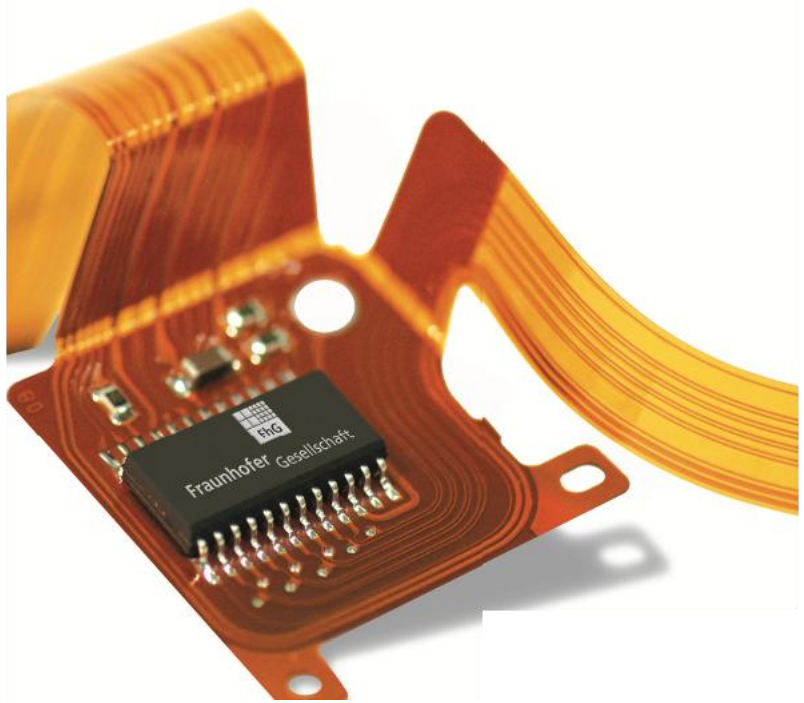


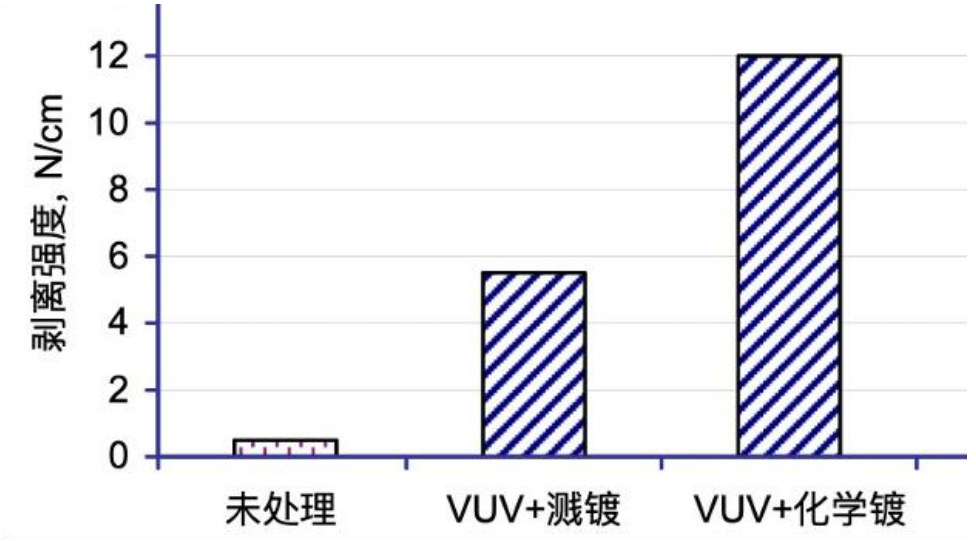
预处理后涂布



UV光接枝工艺

- 表面活化后
- 可引入其他功能基团-NH_2等
- 嫁接其它亲水基团



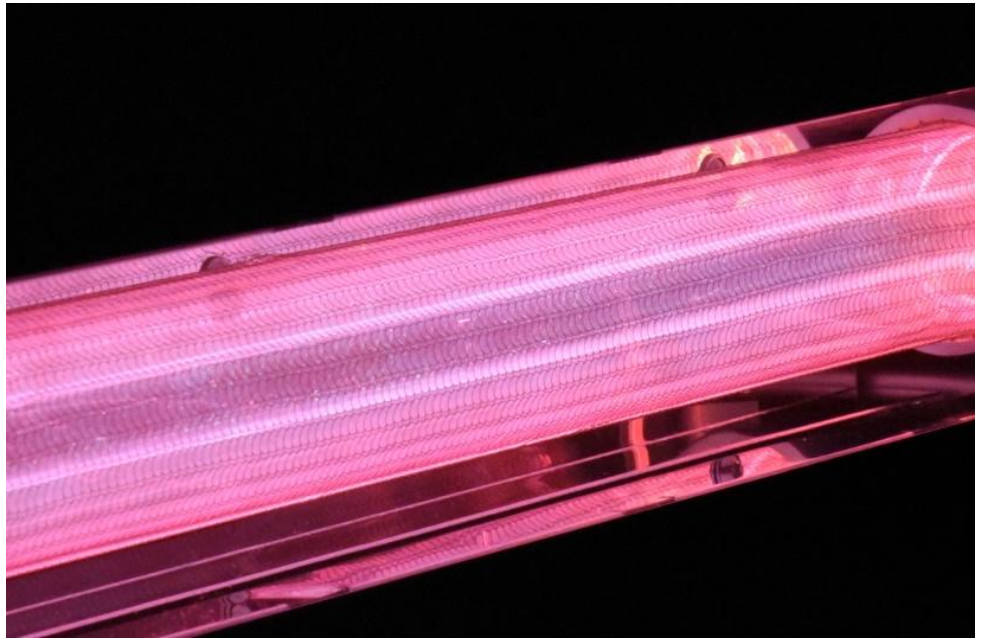


PI膜材表面多种预处理镀铜工艺，铜层的剥离强度比较

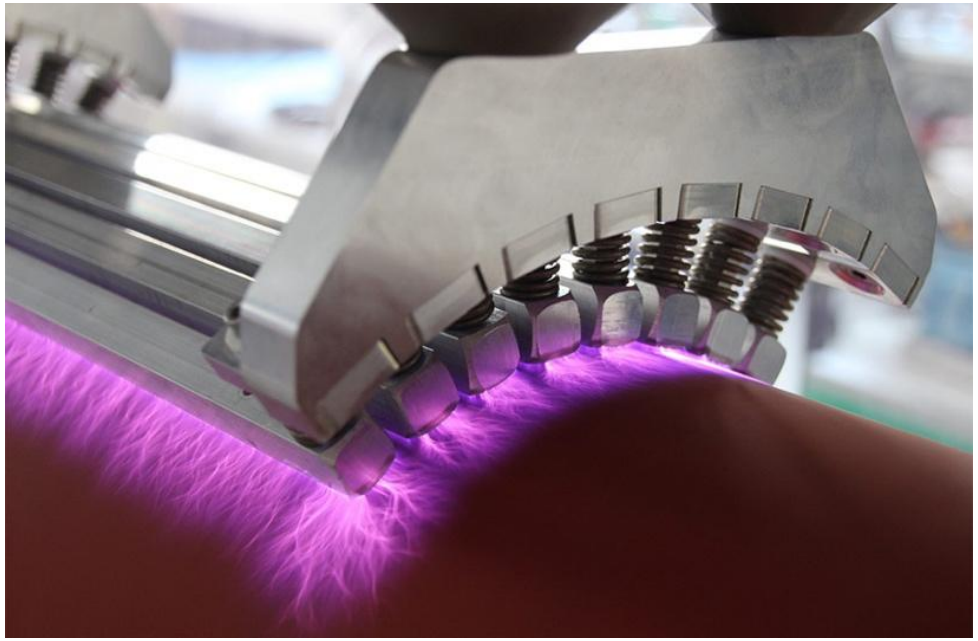
VUV+溅镀：
VUV/NH_3表面预处理后，溅射种子层，后电镀增厚30um。

VUV+化学镀：
VUV/NH_3表面预处理后，化学镀种子层，后电镀增厚30um。

准分子UV光处理工艺对比



准分子UV技术



等离子技术

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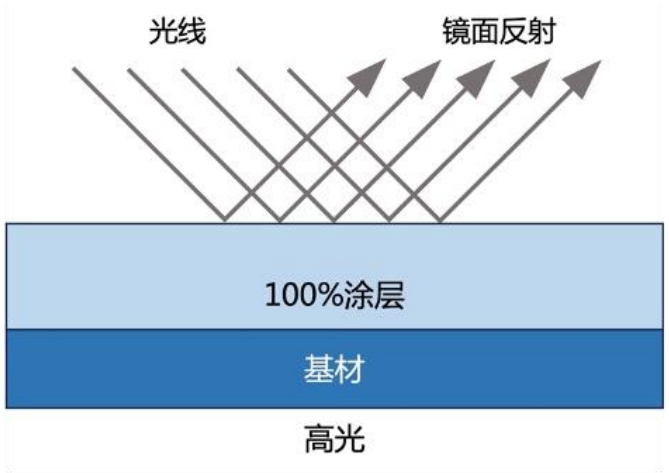
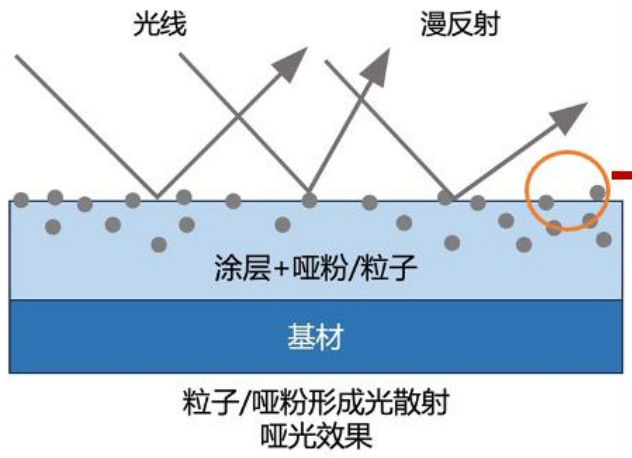
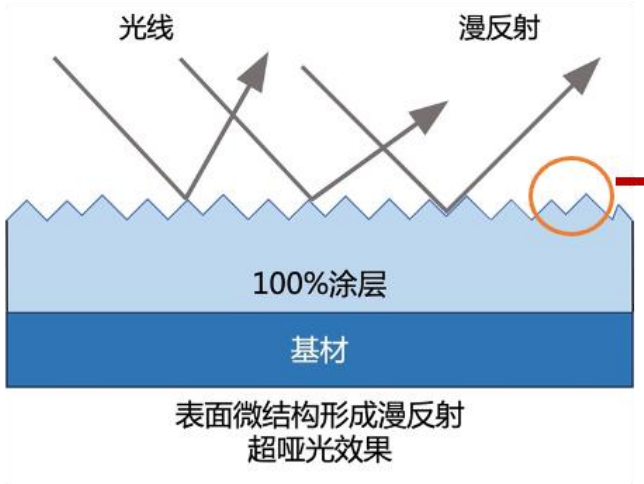
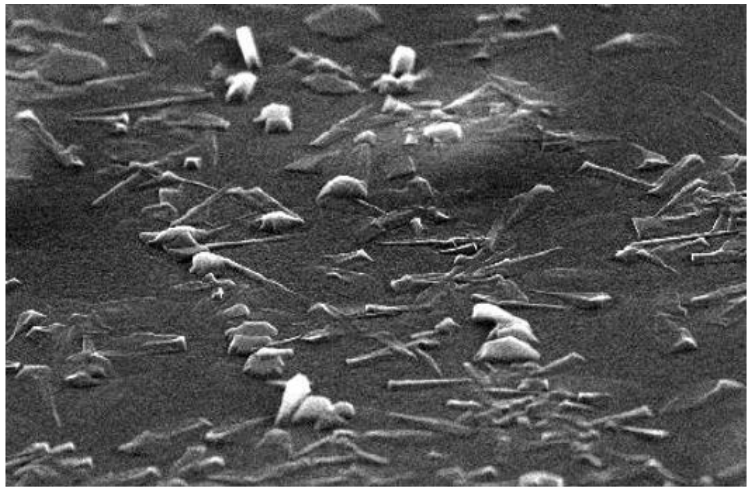
准分子UV光固化
--超哑肤感/微结构

准分子UV物理消光技术

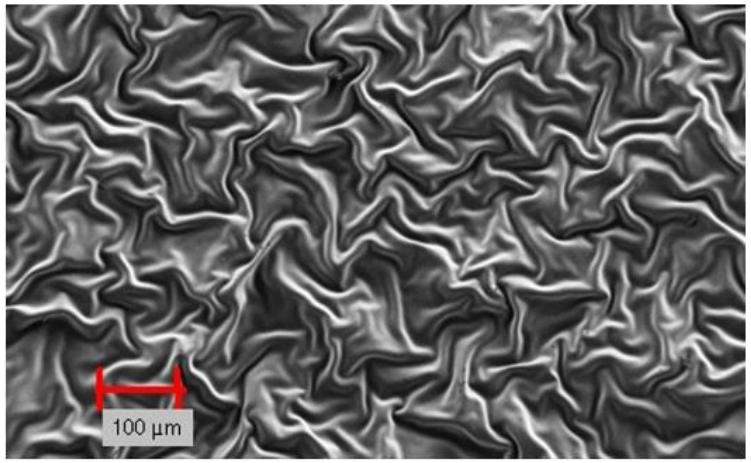








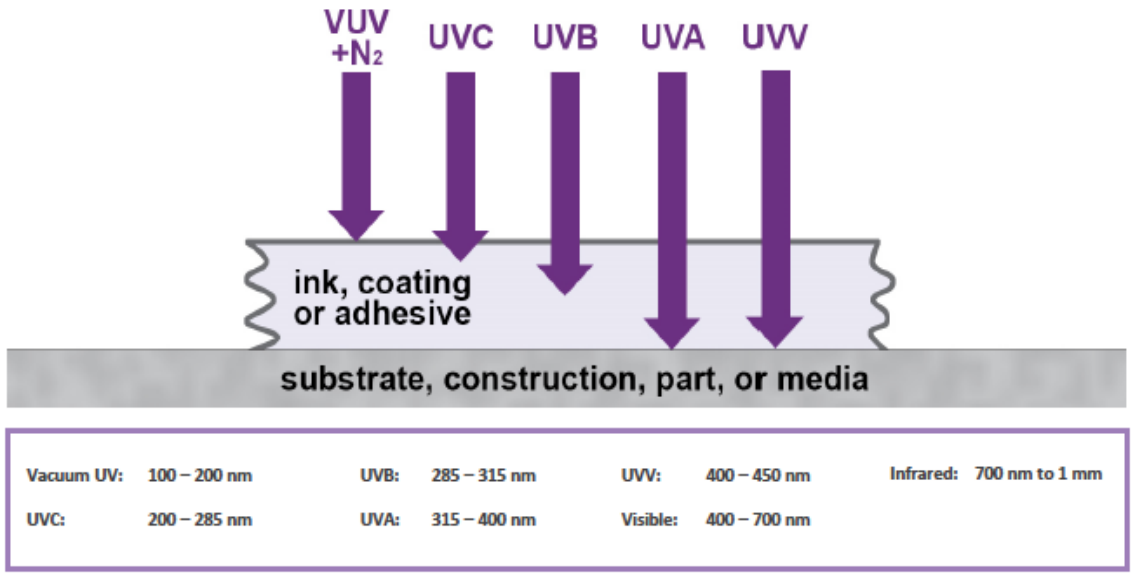
哑粉涂层表面放大图



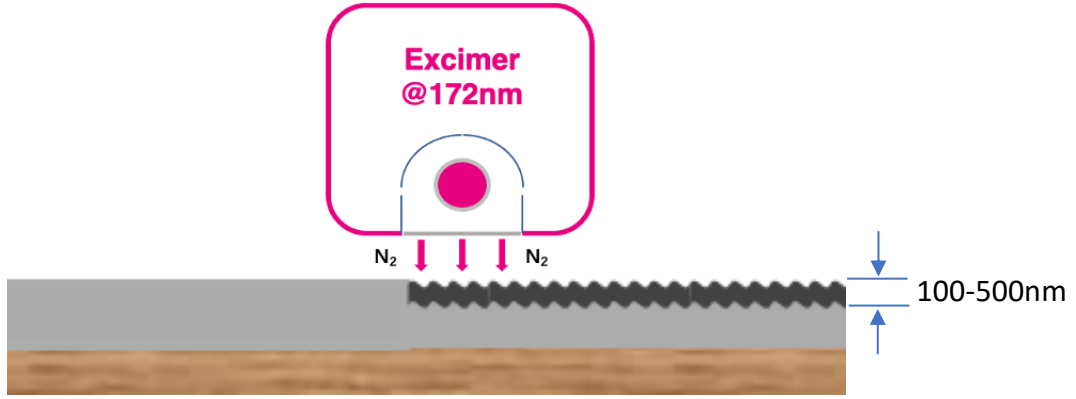
微褶皱结构表面放大图

准分子物理消光原理：涂层微褶皱形成漫反射

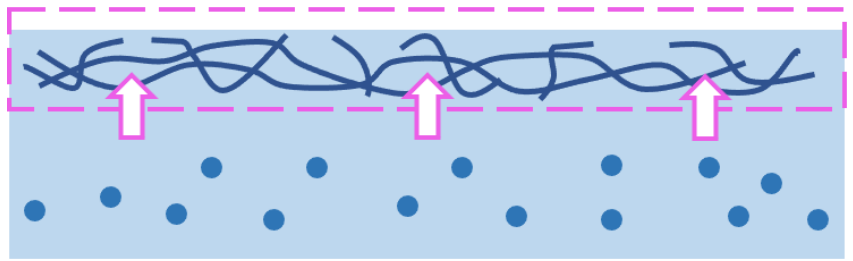
褶皱微结构形成机理



波长越短，能量越高，但穿透能力越弱

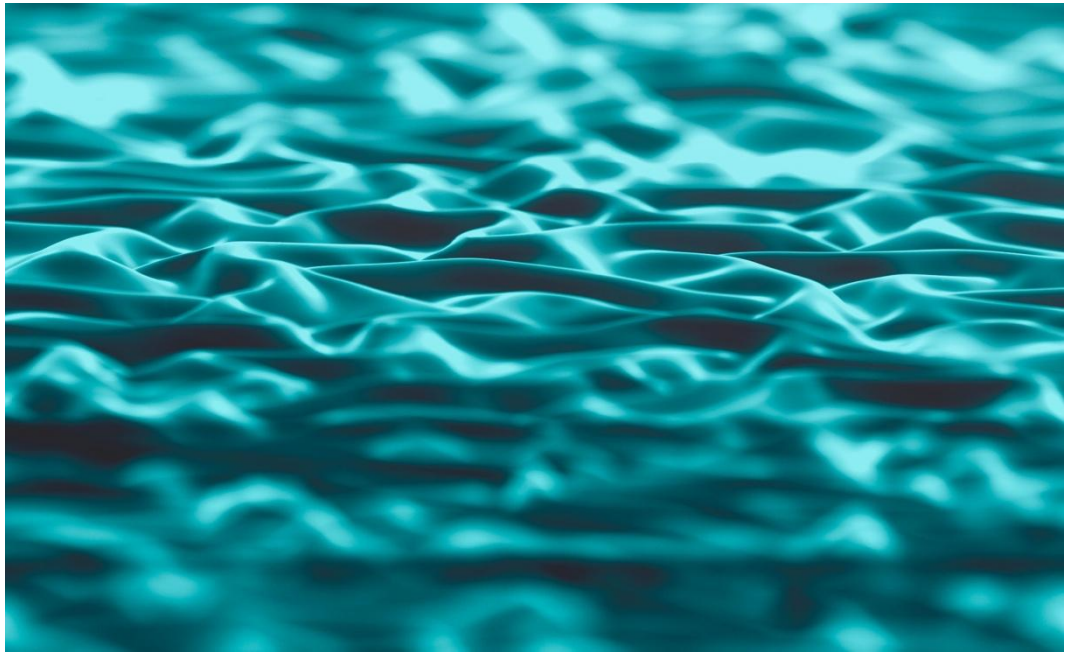


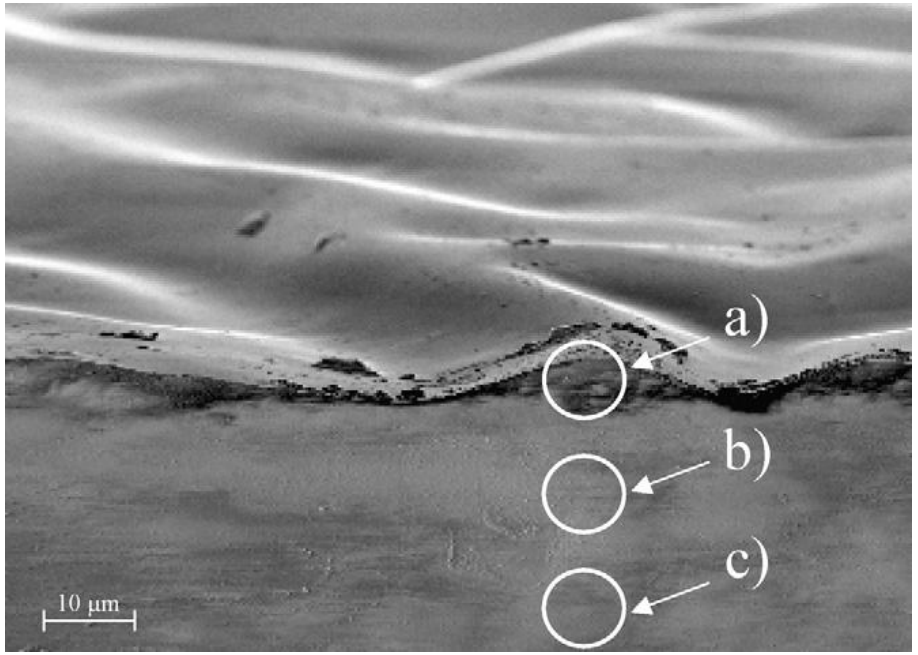
172nm光的穿透很弱，只有浅表层固化



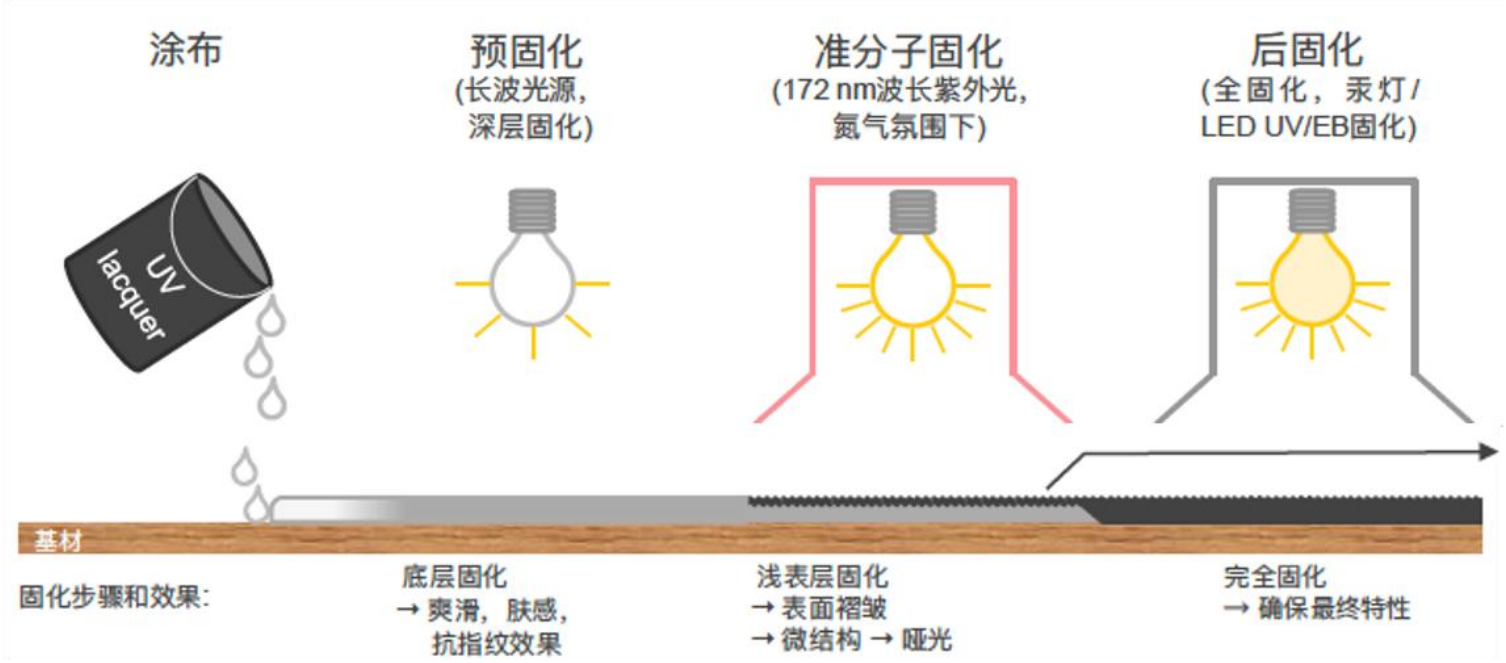
下层未固化的液态树脂向表层膨胀移动，表层受力产生褶皱

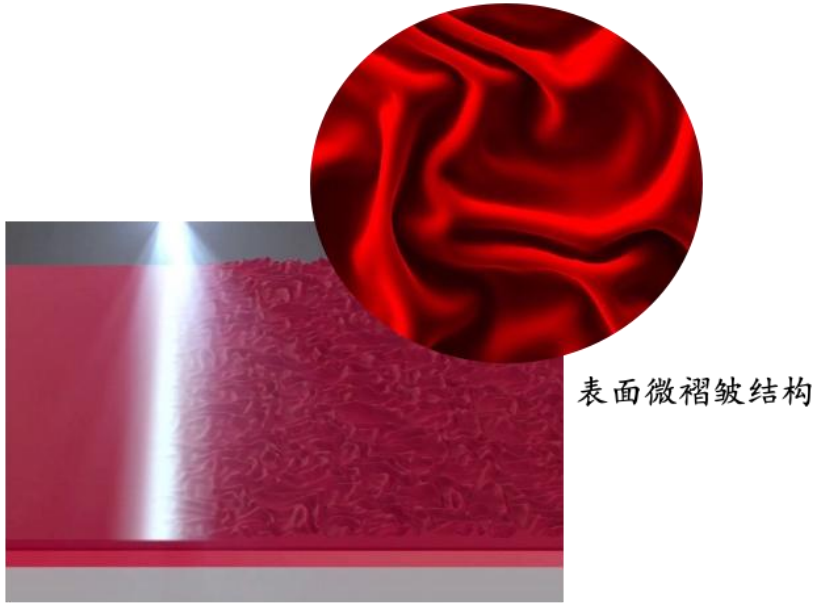
微结构褶皱3D效果





固化工艺：准分子UV超哑光/微结构





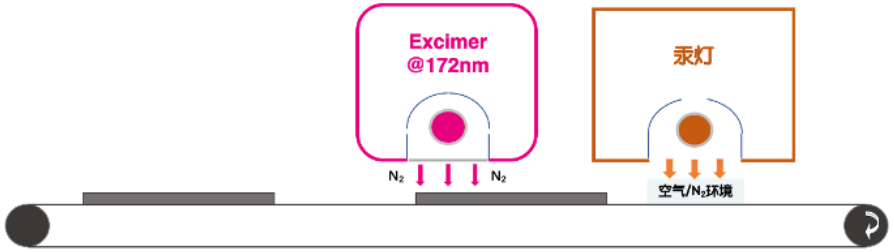
表面微褶皱结构

- 涂料底层预固化
- 385-400nm UV光源初步固化
- 镓灯/LED UV

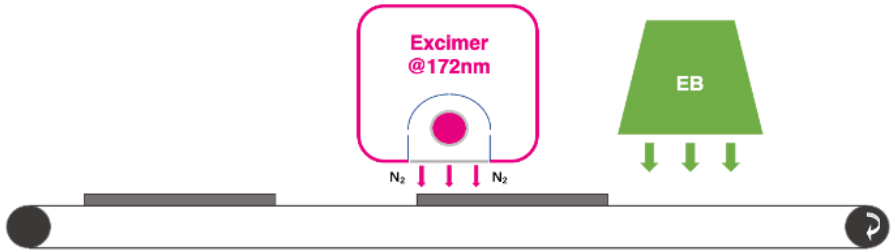
- 氮气环境下
- 172nm UV固化表层
- 涂层形成褶皱微结构
- 实现物理消光效果

- 完全固化
- 汞灯/LED UV
- EB固化

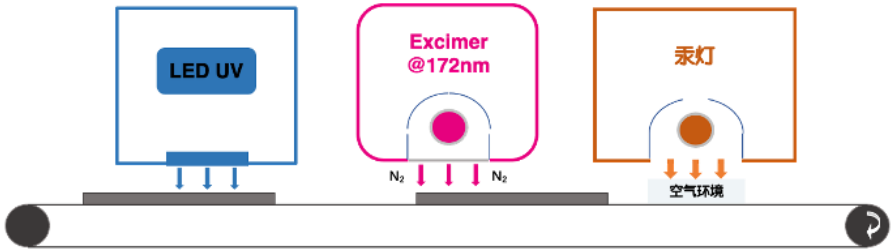
不同的固化工艺配置



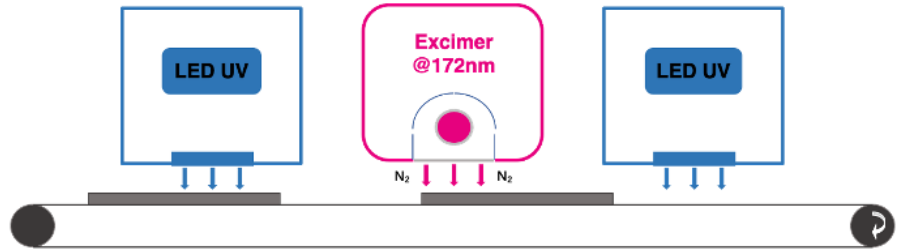
172nm准分子+汞灯(空气/N_2氛围)



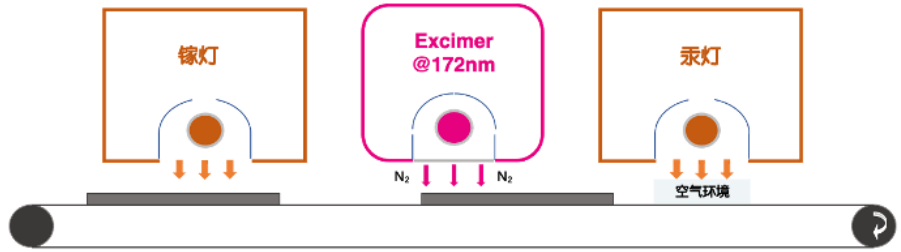
172nm准分子+电子束



LED UV+172nm准分子+LED UV

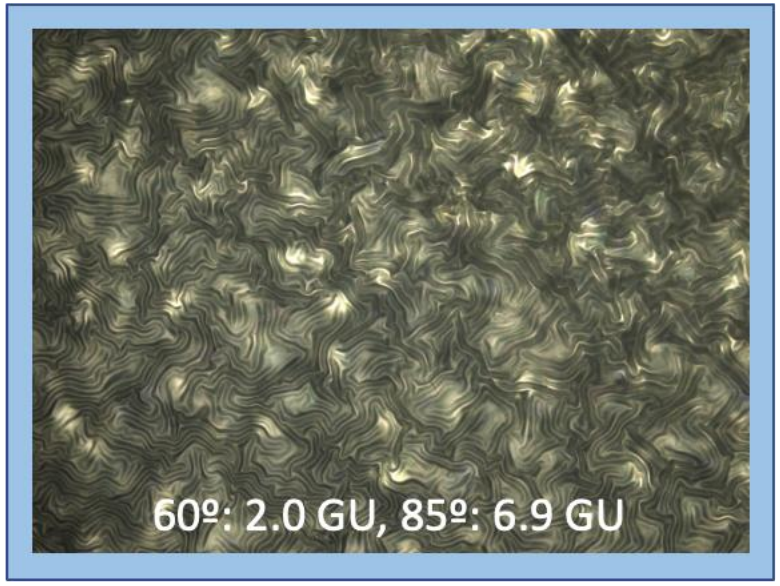


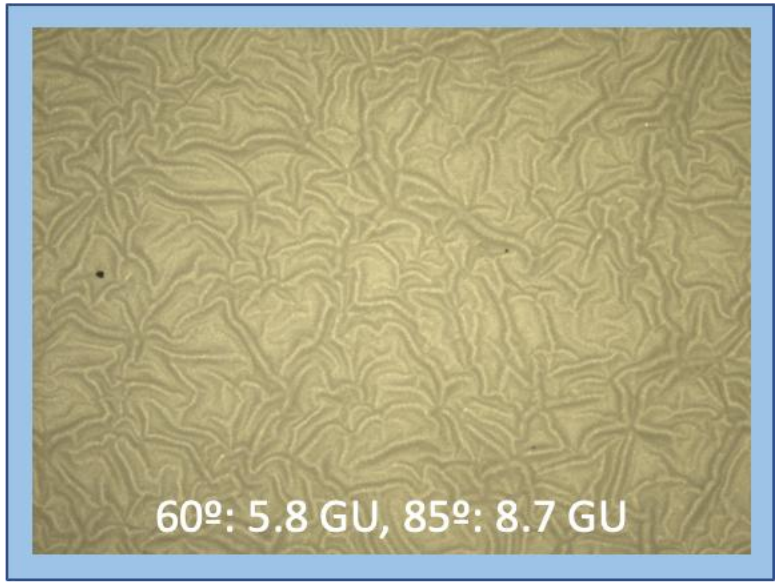
LED UV+172nm准分子+汞灯

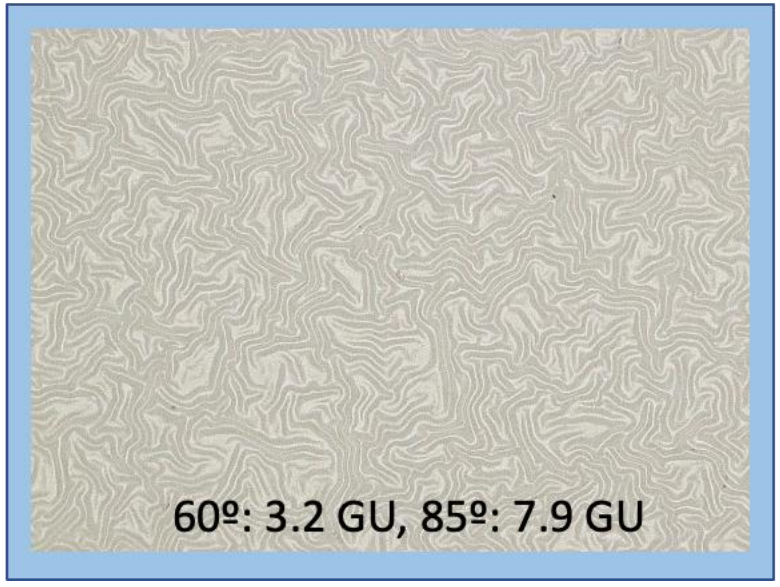


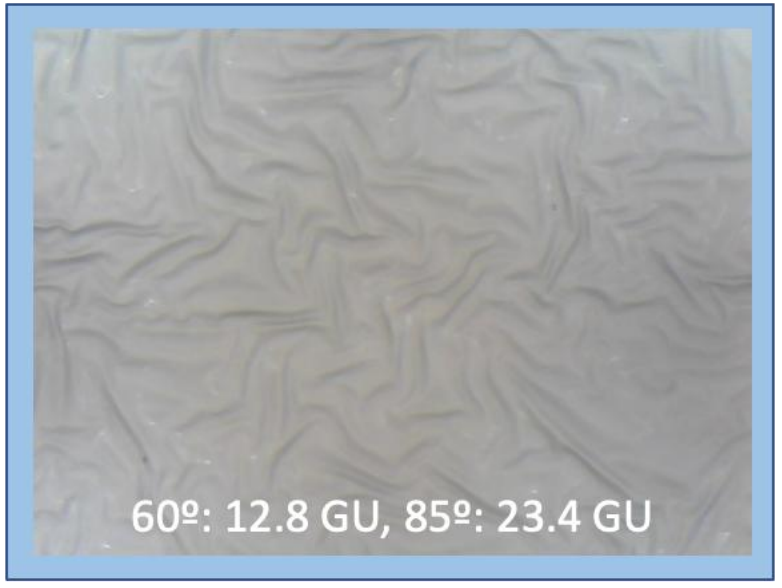
镓灯+172nm准分子+汞灯

不同树脂的褶皱效果


60º: 2.0 GU, 85º: 6.9 GU

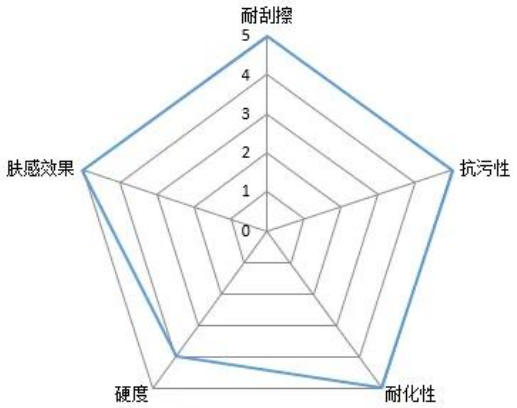

60º: 5.8 GU, 85º: 8.7 GU

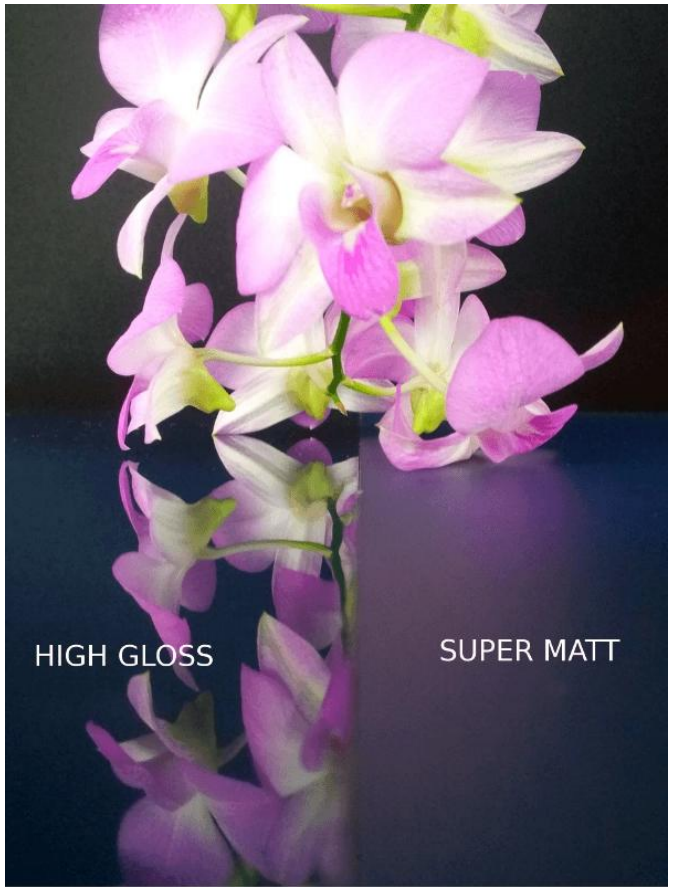

60º: 3.2 GU, 85º: 7.9 GU


60º: 12.8 GU, 85º: 23.4 GU

准分子UV微结构工艺特点

- 不需要添加粒子和溶剂
- 超哑光表面（1.5 - 5 GU）
- 表面硬度增加（4H）
- 抗刮擦性能提高
- 耐污耐化学性提高
- 防指纹表面
- 表面触感极其柔软丝滑
- 更高的雾度，>95%(依据配方)
- 更环保





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UV光化学反应
--水氧阻隔膜

光化学反应机理

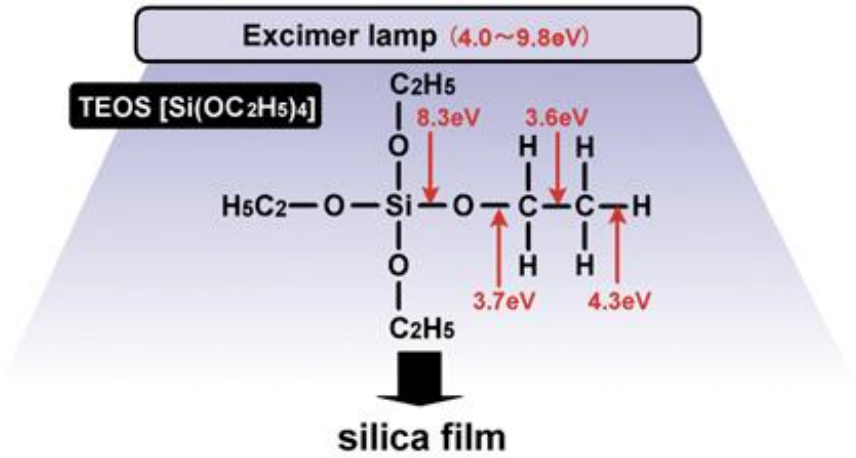
前驱体溶液

172nm VUV

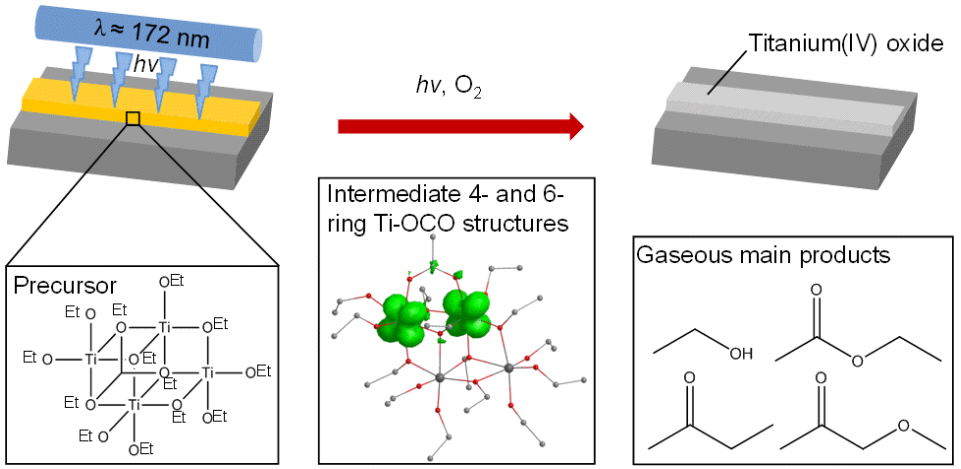
室温，N_2/空气氛围

MO_x金属氧化物

TiO_x
SiO_x
SnO_x
ZnO
.....



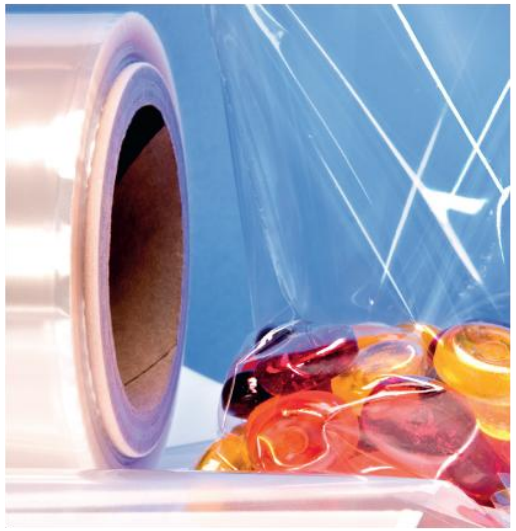
前驱体TEOS制备SiO_x膜层
光化学反应机理



前驱体$Ti(OEt)_4$制备TiO_x膜层
光化学反应机理

水氧阻隔封装需求

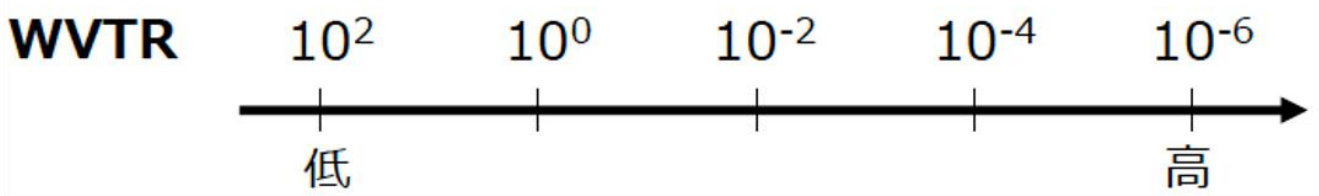
食品医药包装



量子点

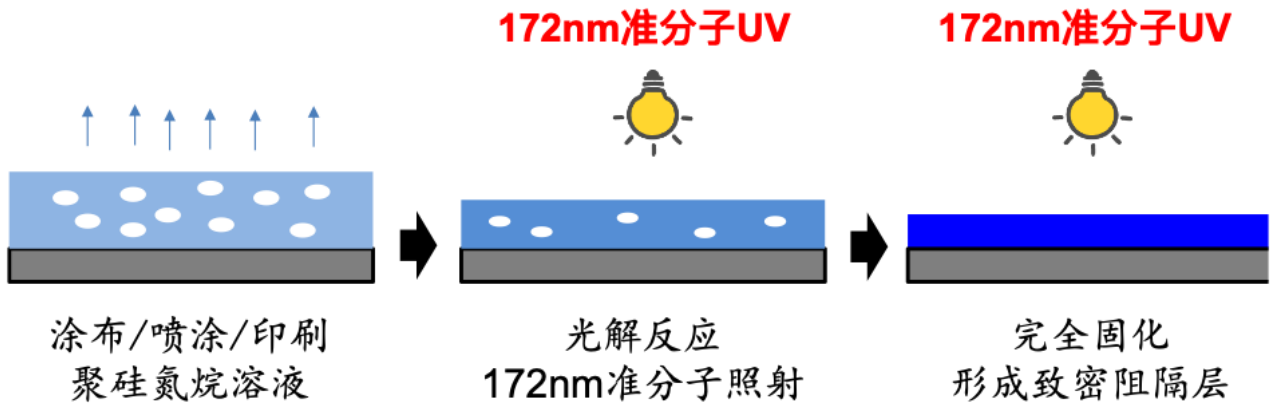
钙钛矿/有机太阳能电池

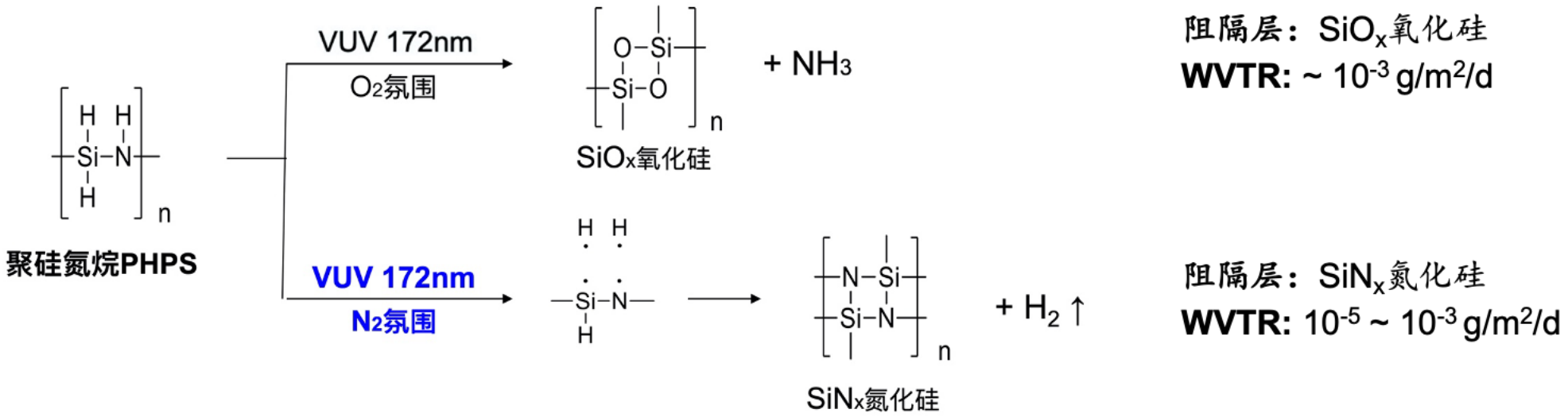
OLED



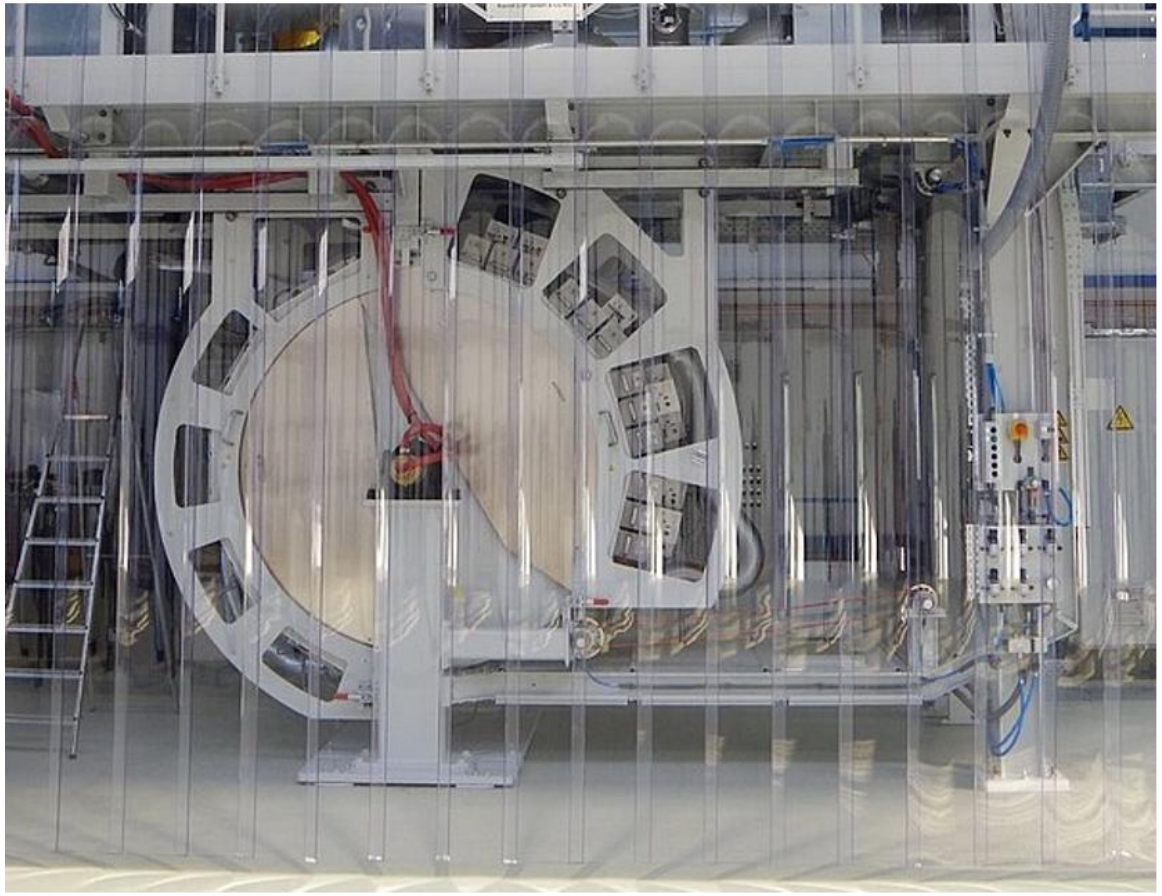
水汽/氧气阻隔性能需求增加

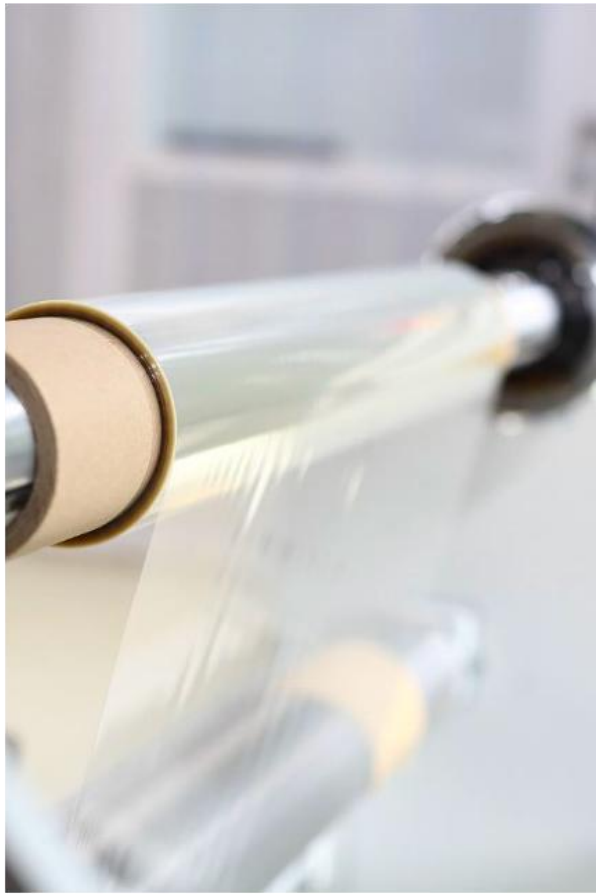
水氧阻隔层制备


172nm准分子UV
172nm准分子UV
涂布/喷涂/印刷
聚硅氮烷溶液
光解反应
172nm准分子照射
完全固化
形成致密阻隔层


聚硅氮烷PHPS
VUV 172nm
O2氛围
SiOx氧化硅
+ NH3
阻隔层：SiOx氧化硅
WVTR: ~ 10-3 g/m2/d
VUV 172nm
N2氛围
SiNx氮化硅
+ H2 ↑
阻隔层：SiNx氮化硅
WVTR: 10-5 ~ 10-3 g/m2/d

水氧阻隔层制备

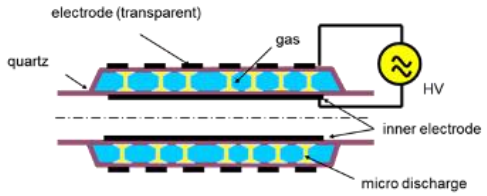




我们的产品方案

研发

制造

等离子体物理	电子	应用
	  电源	
 准分子灯管	 控制器  UV传感器	

核心部件 → 系统解决方案