半導體元件概論講義(6/8)
校內專家演講(1/1)

(2007年教育部 影像顯示科技人才培育計畫)

黃光微影技術與應用(一)，(二)
電漿技術在光電產業之應用

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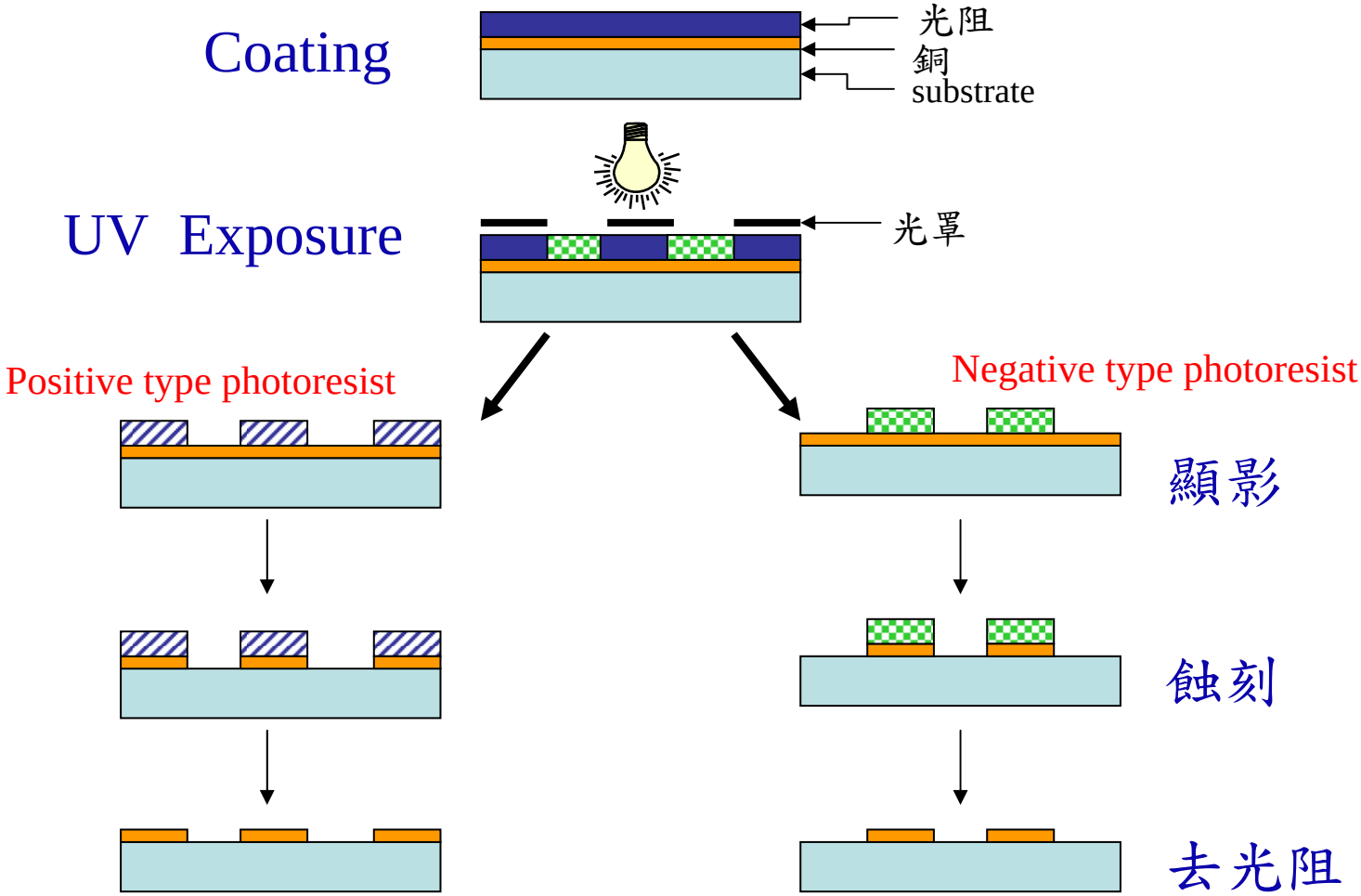
黃光微影技術與應用

Outline

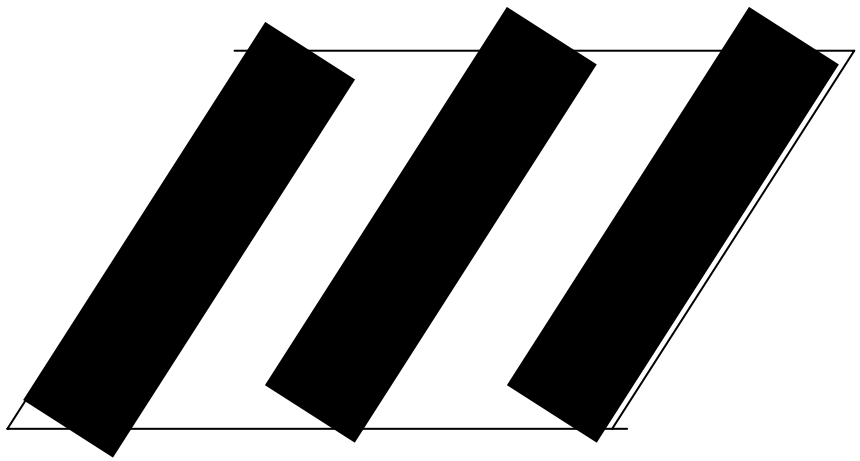
1. An introduction to Microlithography
2. Lithography Process
3. Next Generation Lithography
4. Lithography Process Apply to Others Electronic Products
5. Conclusion

黃光微影成像技術流程
Micro-lithography



黃光室實習操作步驟

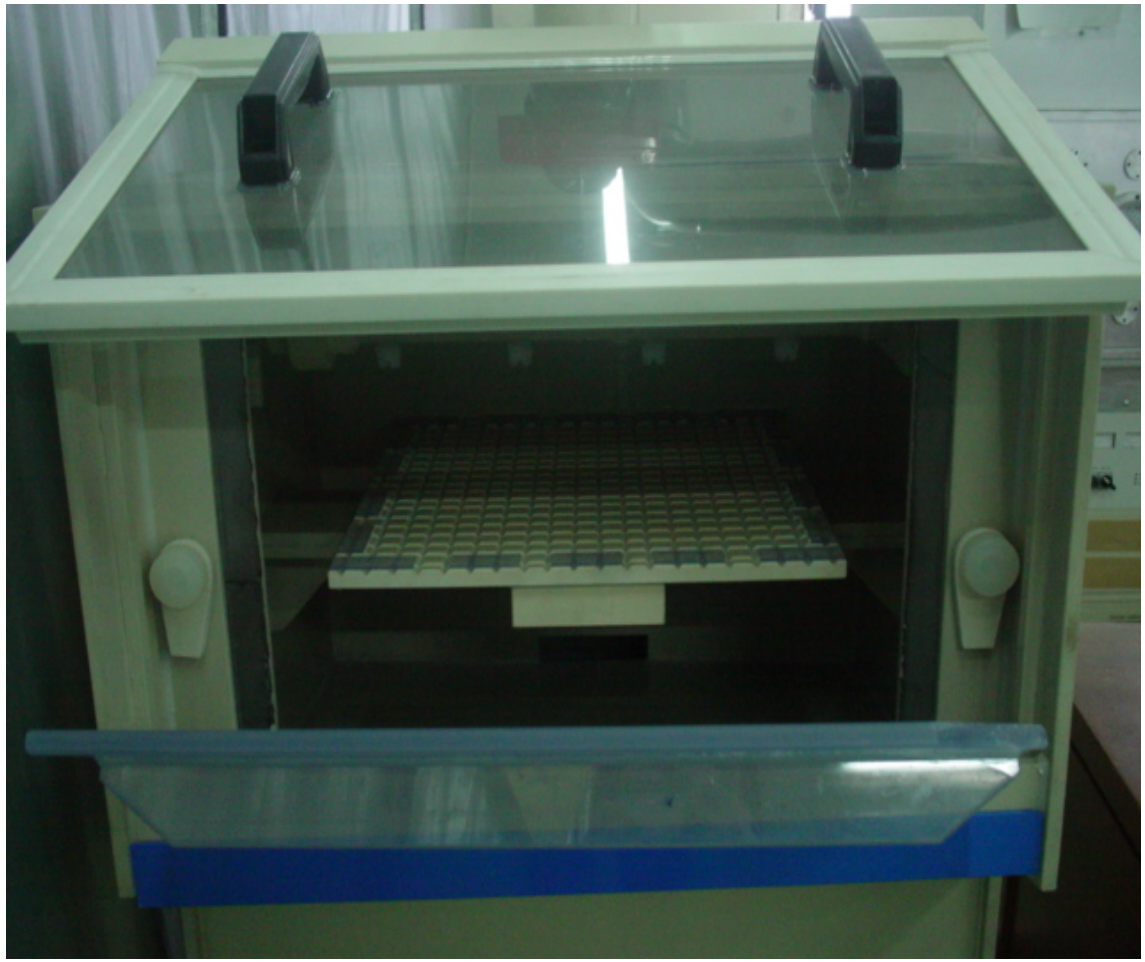
(1)電路設計、光罩製作



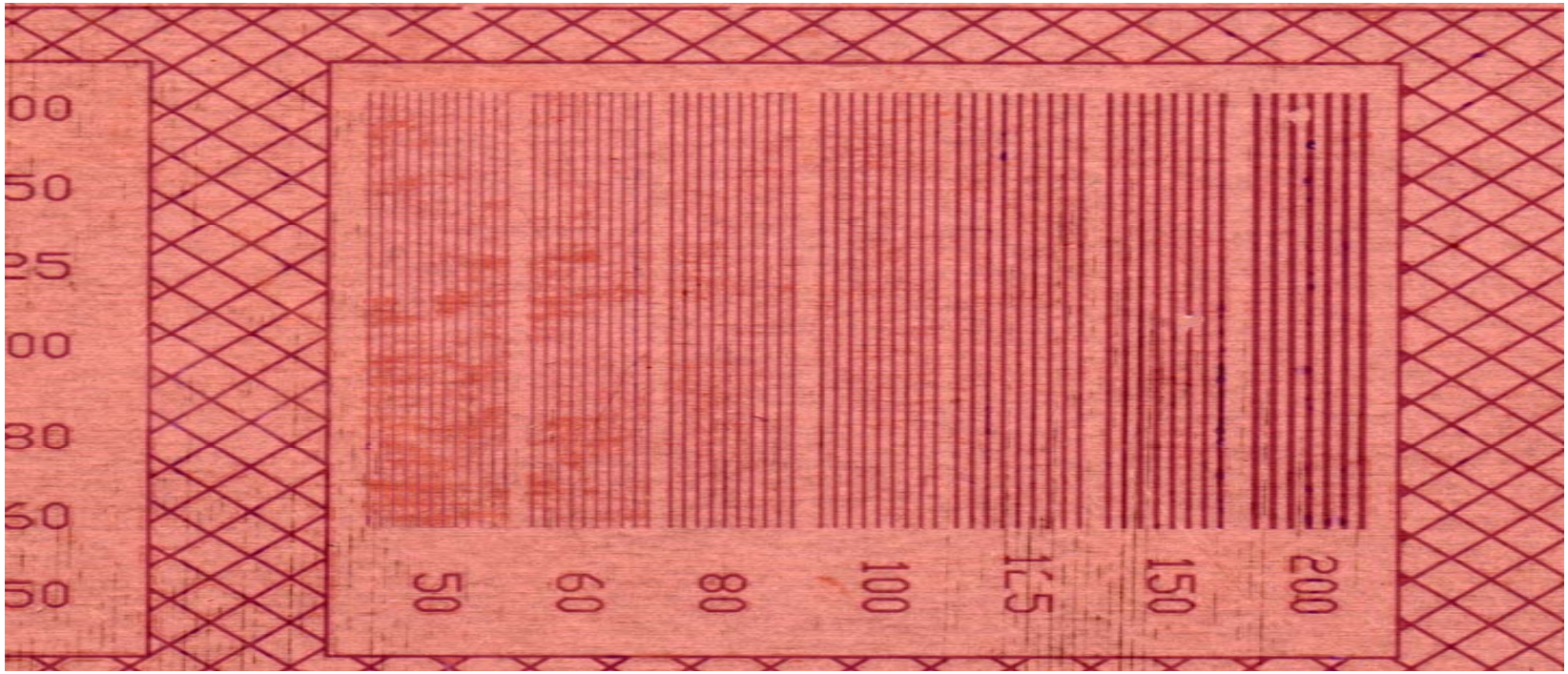
(2) 光阻塗佈

(3) 曝光

(4) 顯影



(5) PCB 板上顯影結果



黃光微影製程
(Photolithography Process)

黃光微影製程設備基本成份

1. Light Sources (光源)
2. Exposure System (曝光系統)
3. Reticle (Mask) (光罩)
4. Lens (透鏡系統)
5. Wafer (晶圓)
6. Photoresist materials (光阻劑)

黃光微影製程用曝光源系統

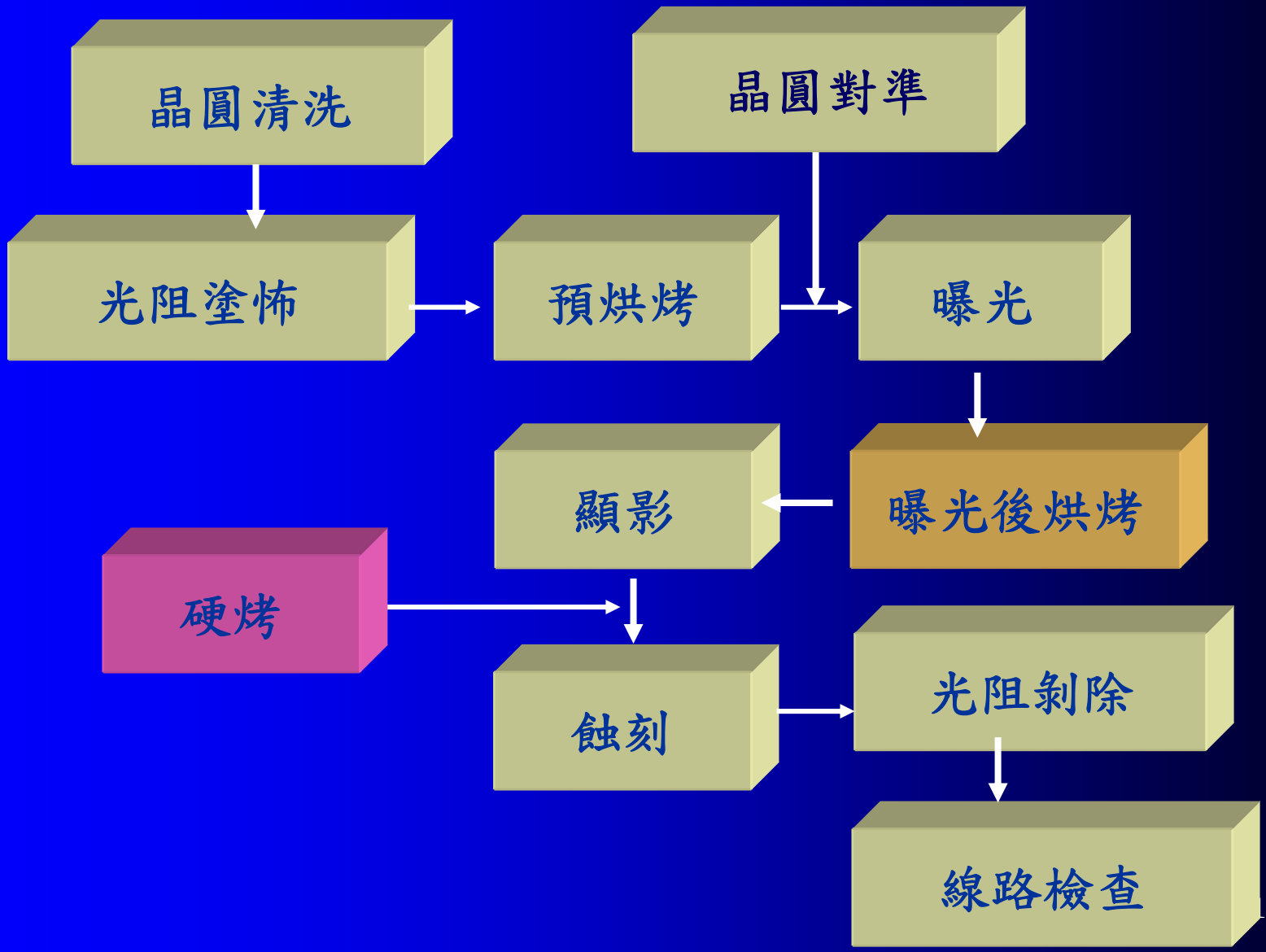
Optics(光學)

- **g-line(436nm), h-line(405nm), i-line(365nm) Hg-Xe lamp**
- **KrF excimer laser (248nm) lithography**
- **ArF excimer laser (193nm) lithography**
- **F2(157nm) laser lithography**

Non-Optics(非光學)

- **EB direct writing (E-Beam)**
- **X-ray proximity printing**
- **EB projection**
- **Ion beam projection**
- **EUV(13.5nm or 11.4nm)**

黃光微影製程步驟



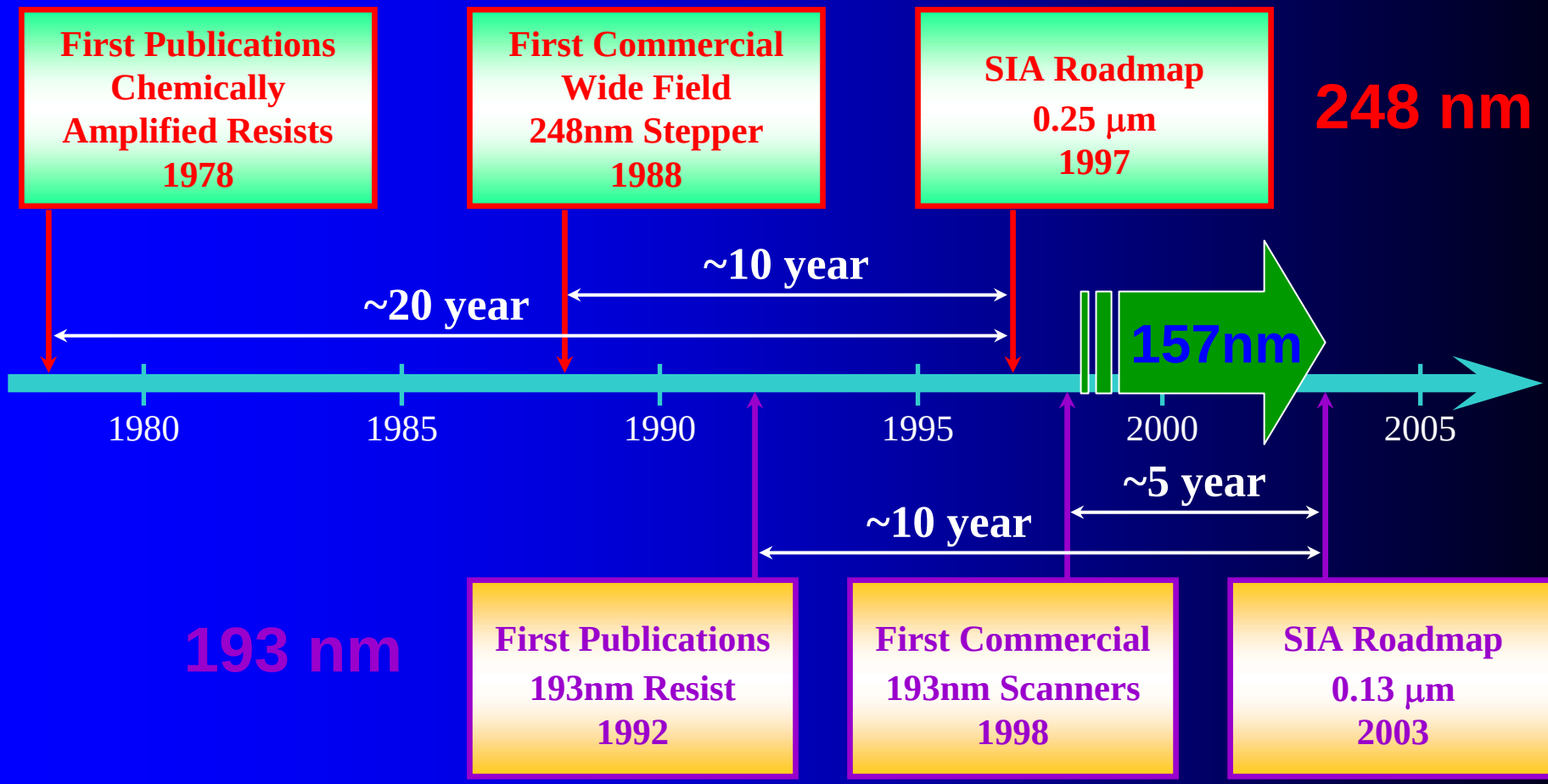
光阻劑旋轉塗佈 (Spin Coating)製程

利用Spin Coating 方法來將光阻劑均勻的塗佈在晶圓表面,並且必需保持光阻劑膜厚之均勻性(uniformity)

曝光(Exposure)步驟

主要利用曝光光源透過具有線路圖案之光罩後,再照射到感光材料(光阻劑)上,使光阻劑發生光化學反應,而造成光阻劑溶解度的差異. 因此將光罩上之線路圖案完全移轉至晶圓表面,此步驟稱之為“曝光”

黃光微影製程曝光系統發展歷史



顯影製程

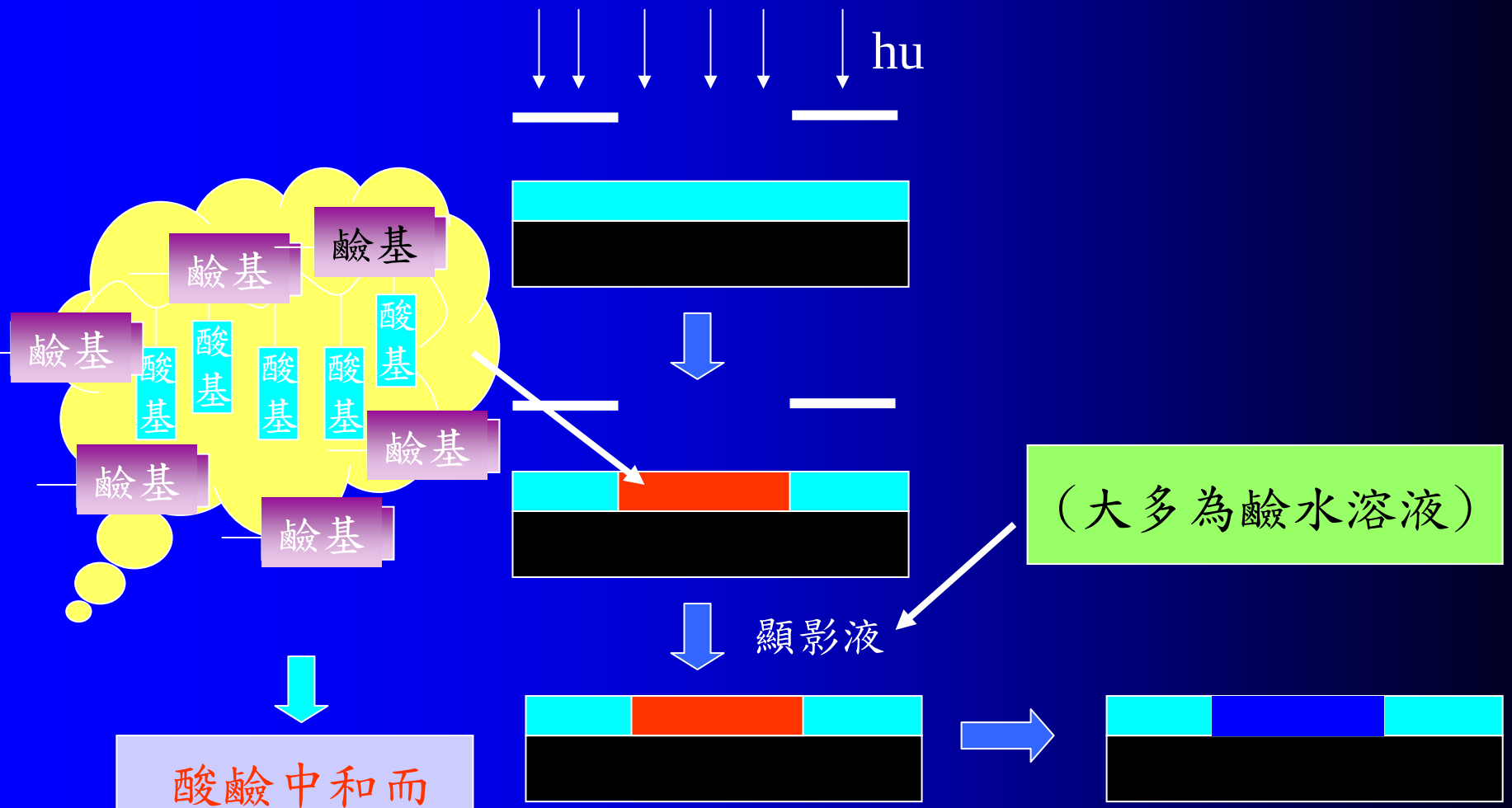
顯影的目的是將光阻劑經由照射後所定義出的圖案顯現在矽晶圓上

- **Positive Resist - Area exposed is removed - Uses TMAH developer**
- **Negative Resist - Area not exposed is removed -**
  Uses Organic Solvent Developer.

顯影步驟:

- **Development by**
  - **–Immersion (Batch)**
  - **–Spray (Batch or Single)**
  - **–Puddle (Single)**
- **Rinse**
- **Dry**

顯影機制



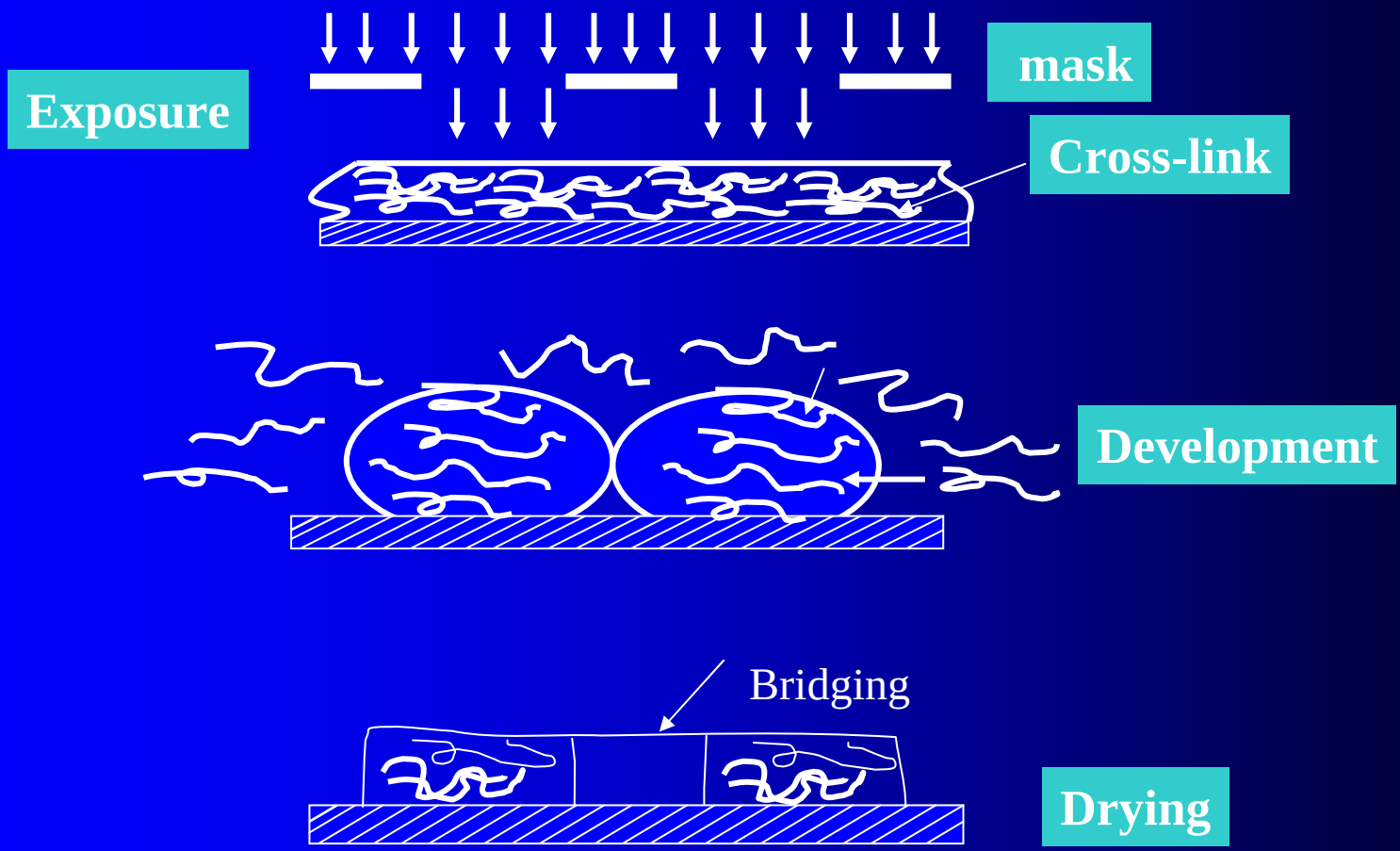
Introduction of Photoresist

什麼是光阻劑？

光阻是一種感光材料，由感光劑（Sensitizer），樹脂（Resin）及溶劑（Solvent）混合而成的材料.

光阻應具備之特性：
(1) 高光源吸收率 (2)高解析度 (3)高無感度 (4)抗蝕劑性
(5)高附著性 (6)低黏滯係數 (7)高對比
光阻材料有正負之分，正光阻受光照射後分子鍵被剪斷(Chain scission)因而易溶於顯影液，因而負光阻分子鍵則會產生交互鏈台(cross linking) 因而難溶於顯影液

負型光阻劑之膨脹(Swelling)現象



由於負型光阻劑之線路經過顯影後有swelling現象
使的線路圖案無法固定且解析度低,因此在目前IC製程
中早已經不使用負型光阻劑

目前使用之正型光阻劑類型

- DNQ-Novolak Resist(G, I-line 光阻劑)
- 化學增幅型光阻劑(Chemical Amplified Resist)

  (a).248nm 光阻劑

  (b).193nm光阻劑

  (c).157nm光阻劑

蝕刻

1. 電漿蝕刻(Plasma etching)
2. 濺擊蝕刻(Sputtering Etching)
3. 活性離子蝕刻(Reactive ion etching)

電漿蝕刻原理

利用電漿將反應氣體分子解離成對薄膜材質具有反應性(Reactive)離子,然後藉著離子與薄膜間的化學反應,將曝露在電漿下的薄膜,反應成揮發性生成物而被真空系統抽離,而進行薄膜蝕刻動作.

電漿蝕刻具有非等向性蝕刻(anisotropic)之優點,但其選擇性的能力較差,因此目前發展出具有高選擇性與高非等向性蝕刻能力的"**反應性離子蝕刻法**"(Reactive Ion Etch, RIE)

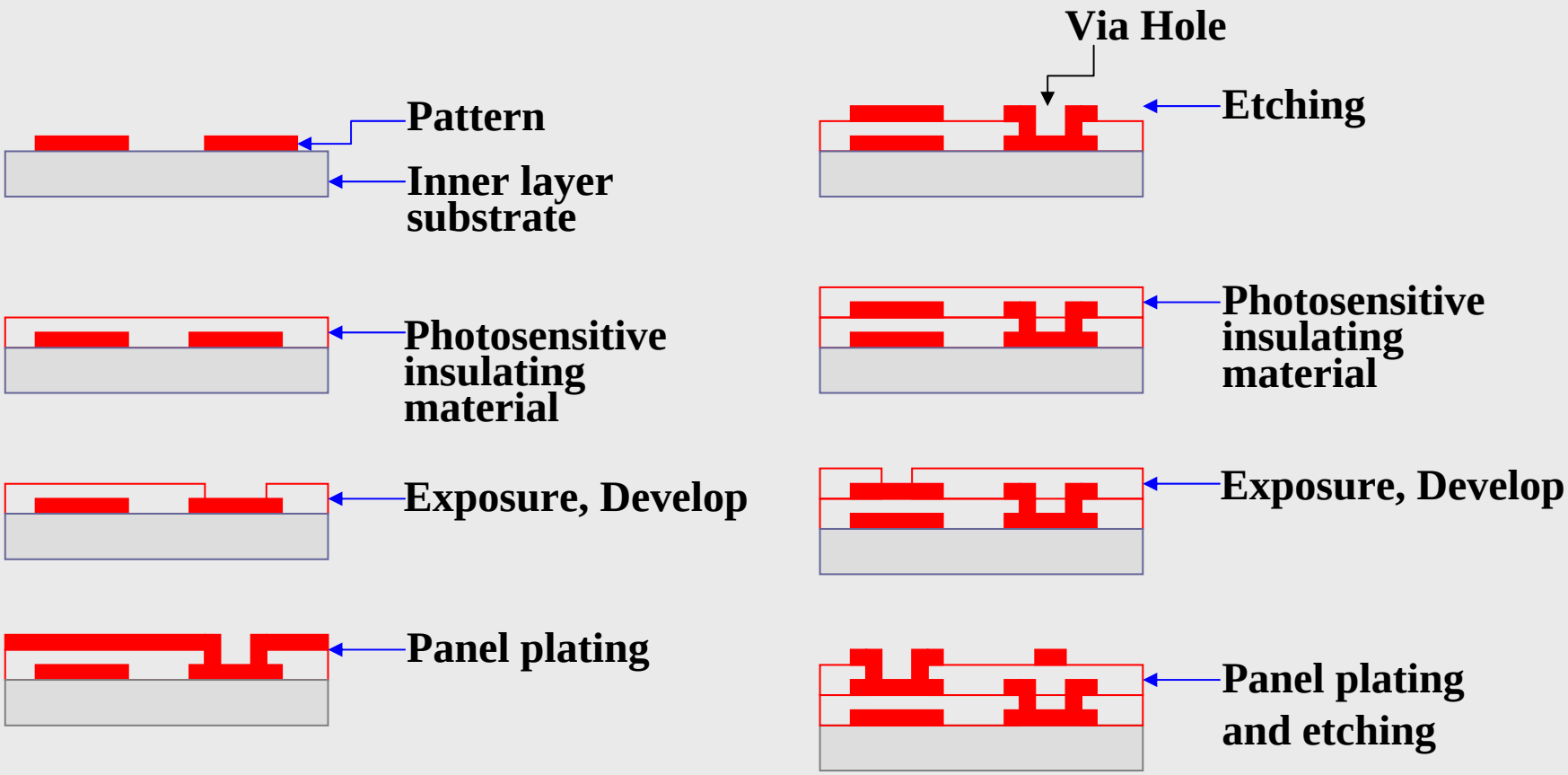
Next Generation Lithography (NGL)

Candidate Technologies

1. F_2 (157nm)
2. Multi-column Electron-Beam Direct Write(MEBDW)
3. Proximity X-ray Lithography (PXL)
4. Ion Projection Lithography (IPL)
5. Extreme UltraViolet lithography (EUV)
6. Electron-beam Projection Lithography (EPL)or (SCALPEL)

Lithography Process Apply to Others Electronic Products

Printed Circuits Board Fabrication Process

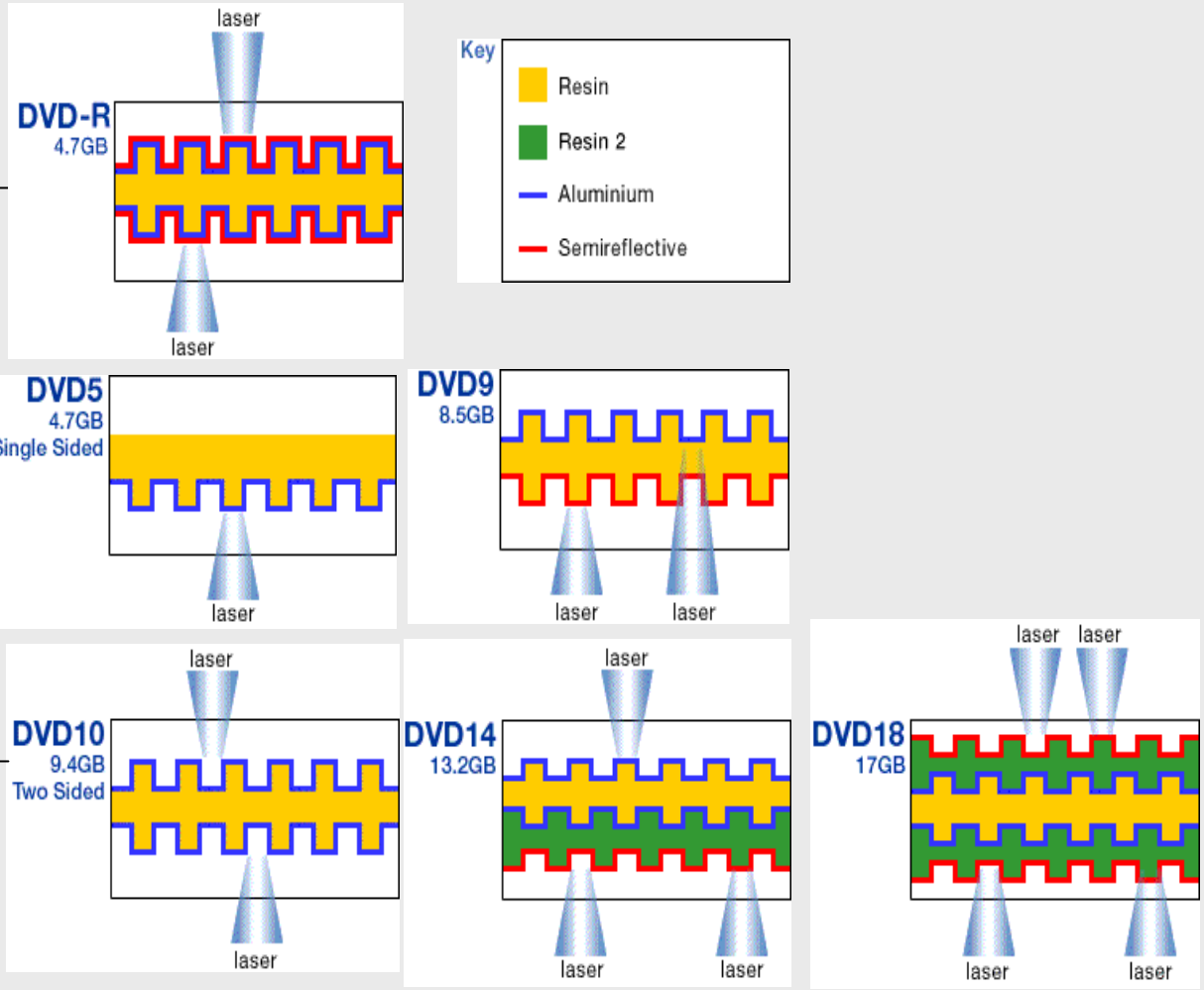


***Photosensitive Insulating Material**

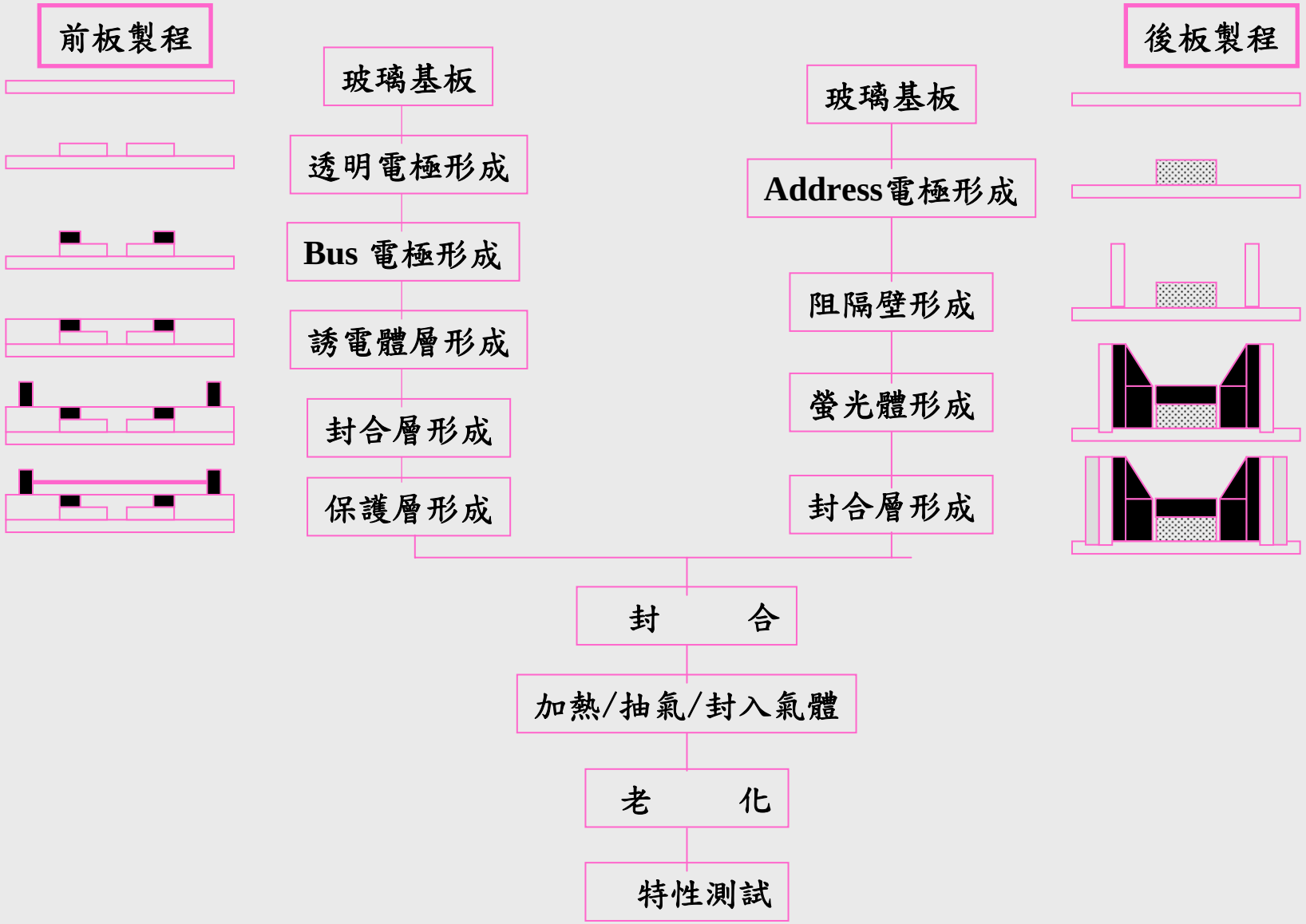
光記錄媒體

Ⅱ

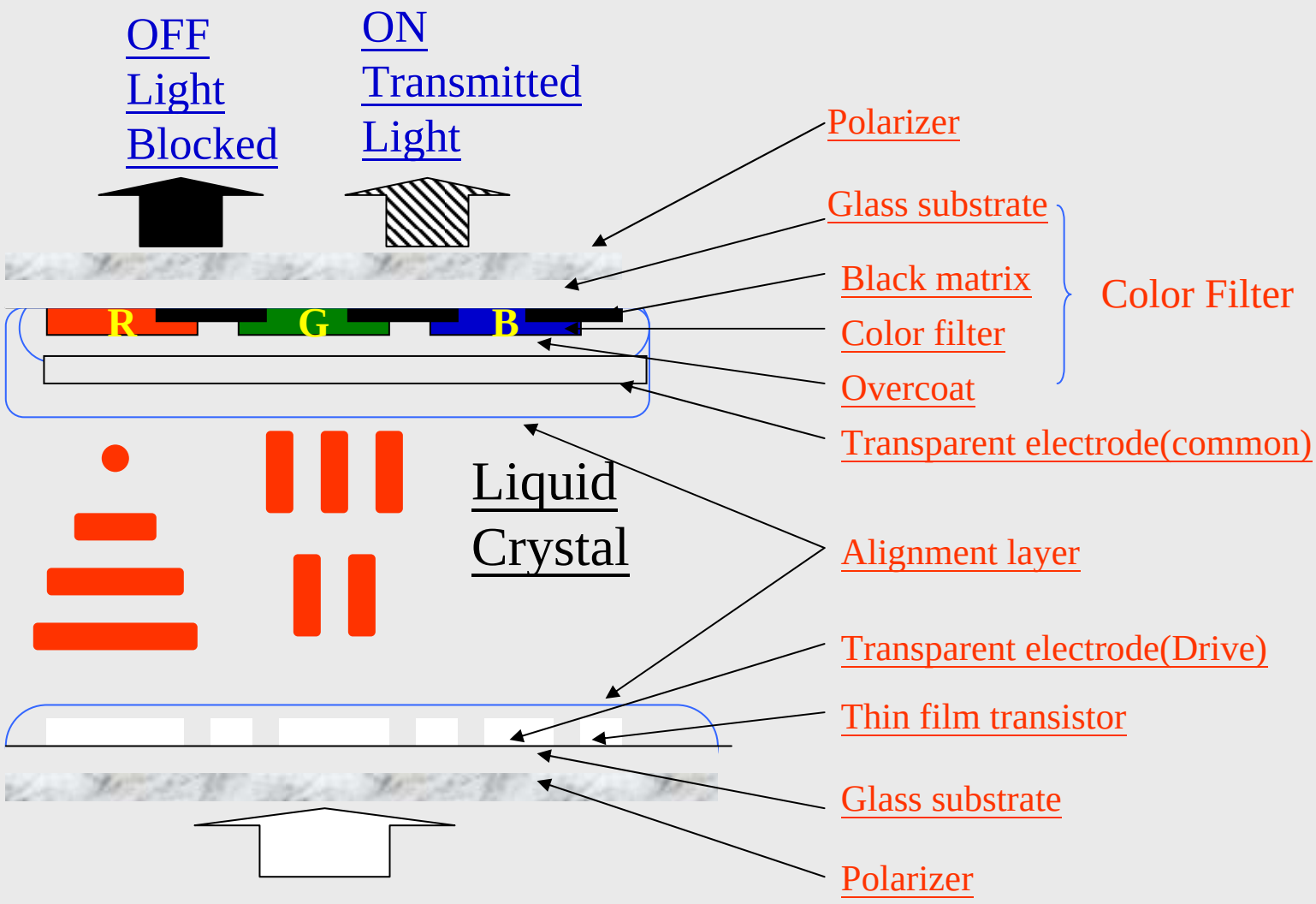
λ =630~650 nm



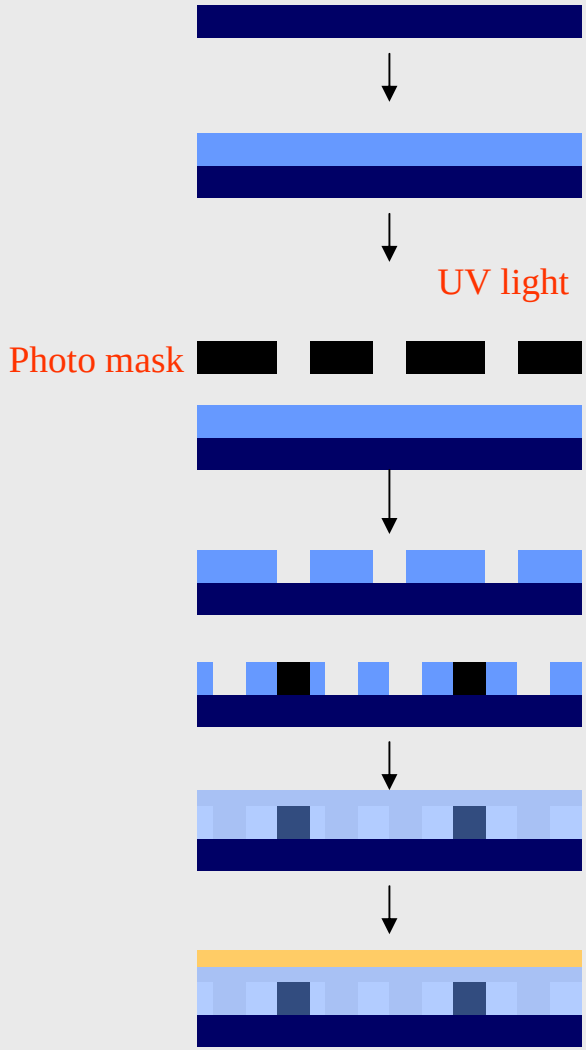
彩色PDP製作

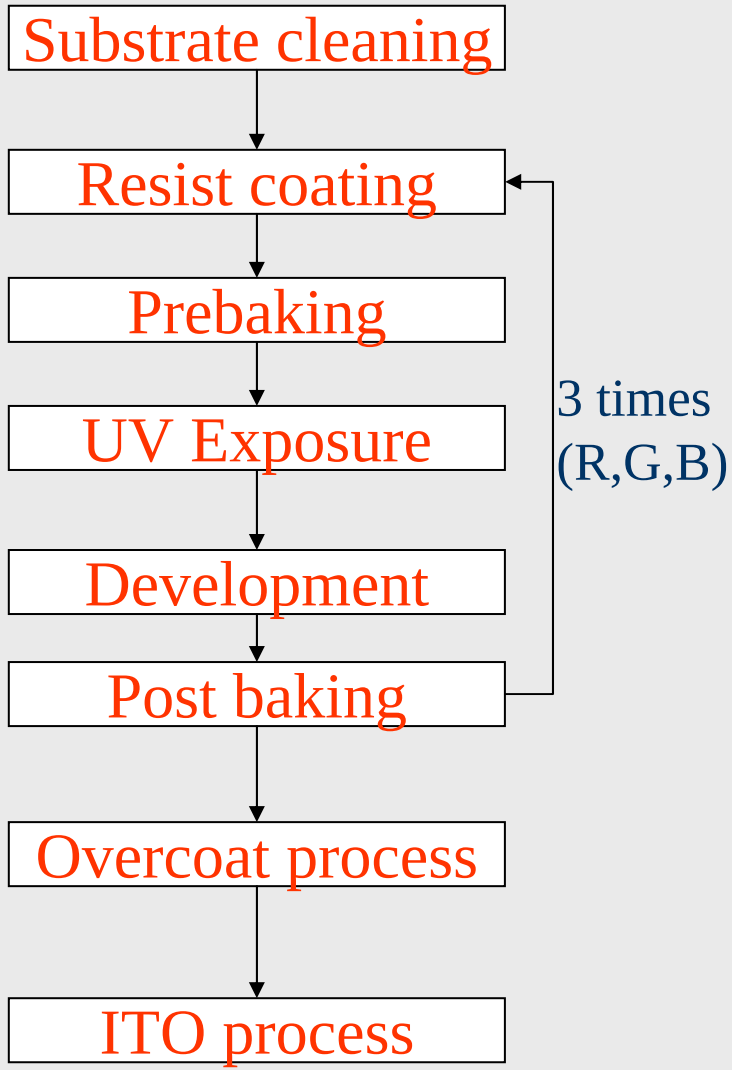

前板製程
玻璃基板
透明電極形成
Bus 電極形成
誘電體層形成
封合層形成
保護層形成
玻璃基板
Address電極形成
阻隔壁形成
螢光體形成
封合層形成
後板製程
封　　合
加熱/抽氣/封入氣體
老　　化
特性測試

Full Color Thin Film Transistor LCD

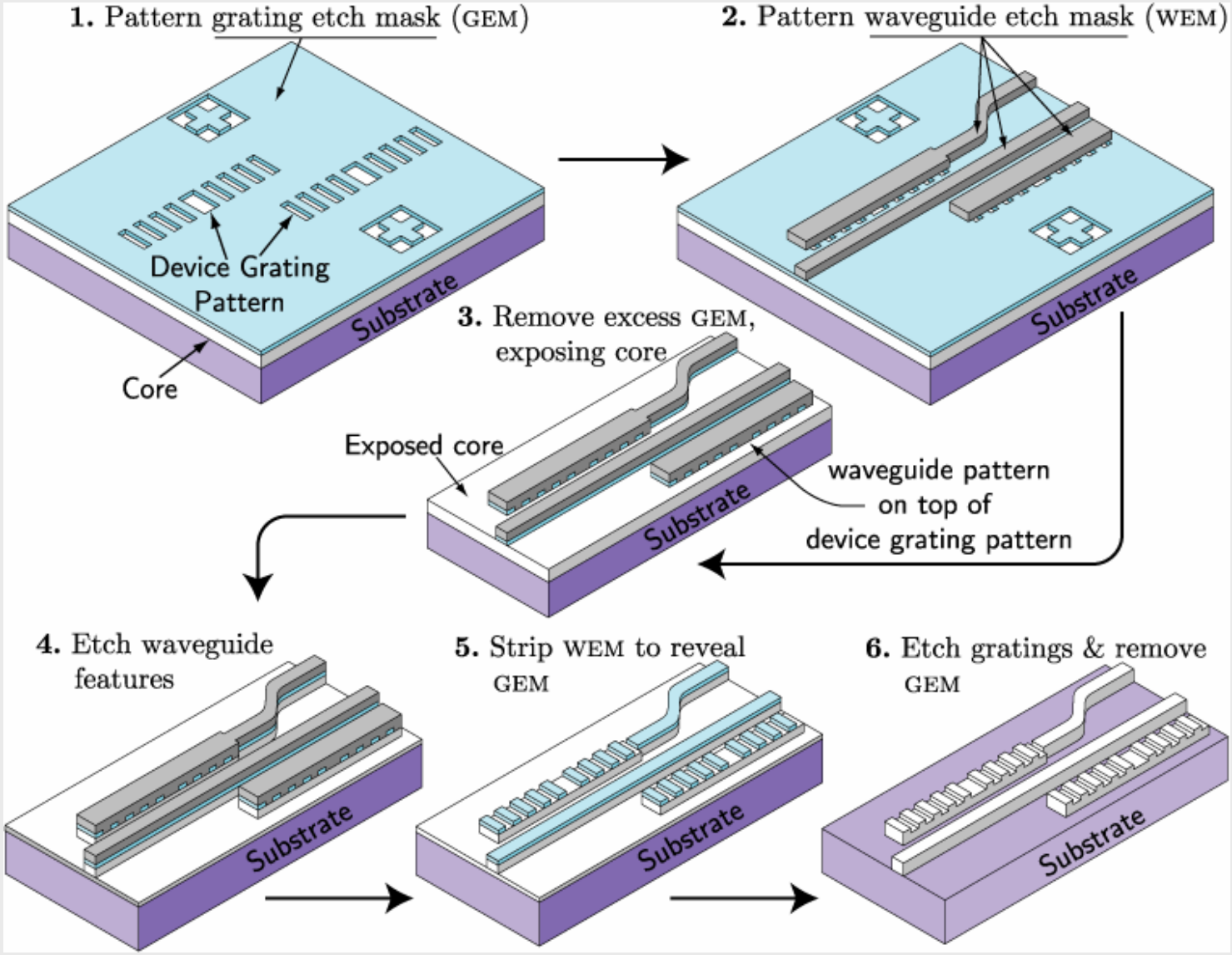


Fabrication of color filter





Waveguide Manufacture Process



Conclusion

“Microlithography is very importance technology and art for any electronic fabrication”

電漿對材料表面處理改善黏著性之研究與應用

Outline

1. Introduction

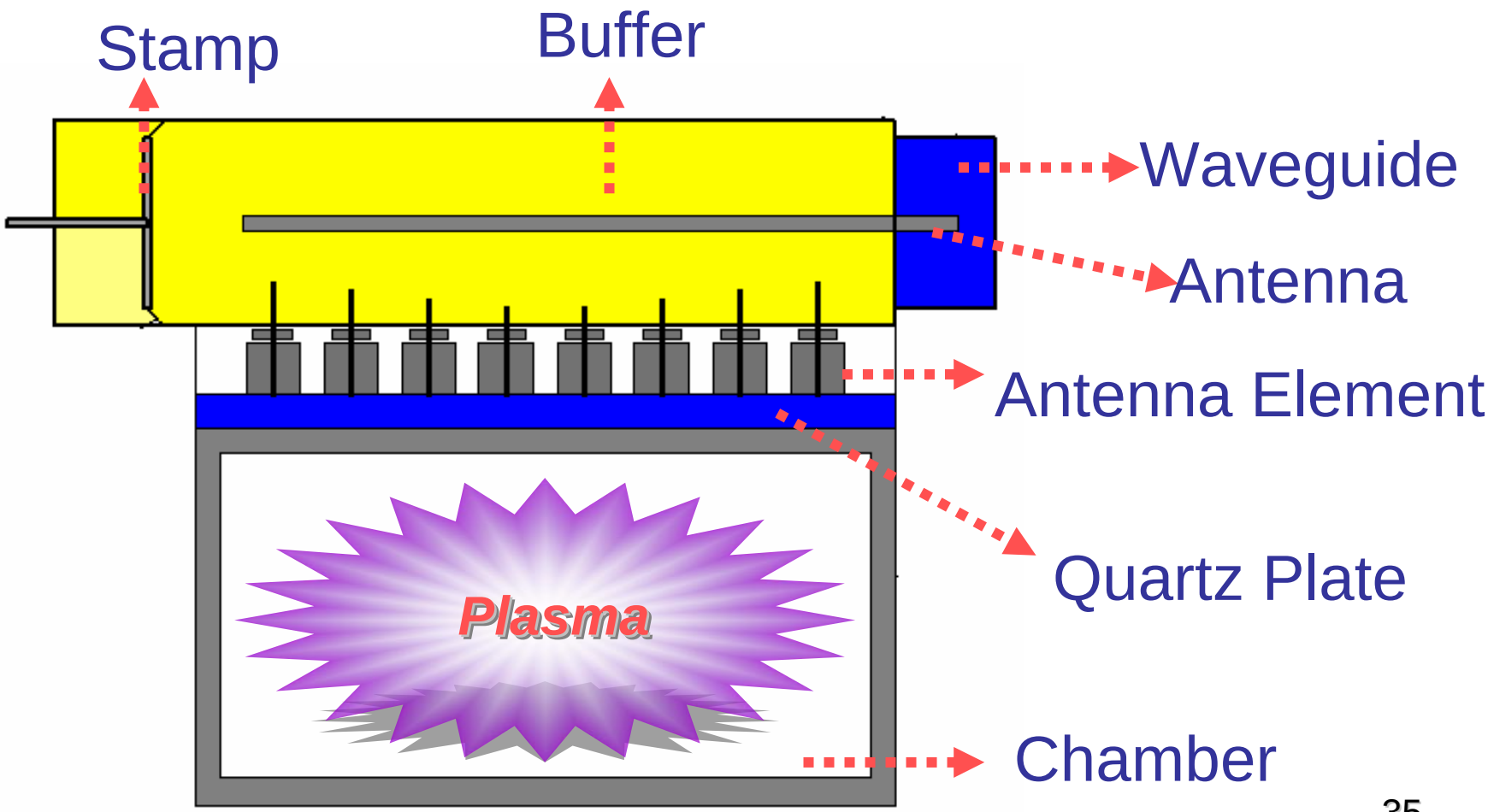
- *Plasma*
- *e-PTFE*
- *Modification*

2. Experiment

3. Result and Discussion

4. Conclusion

微波電漿系統

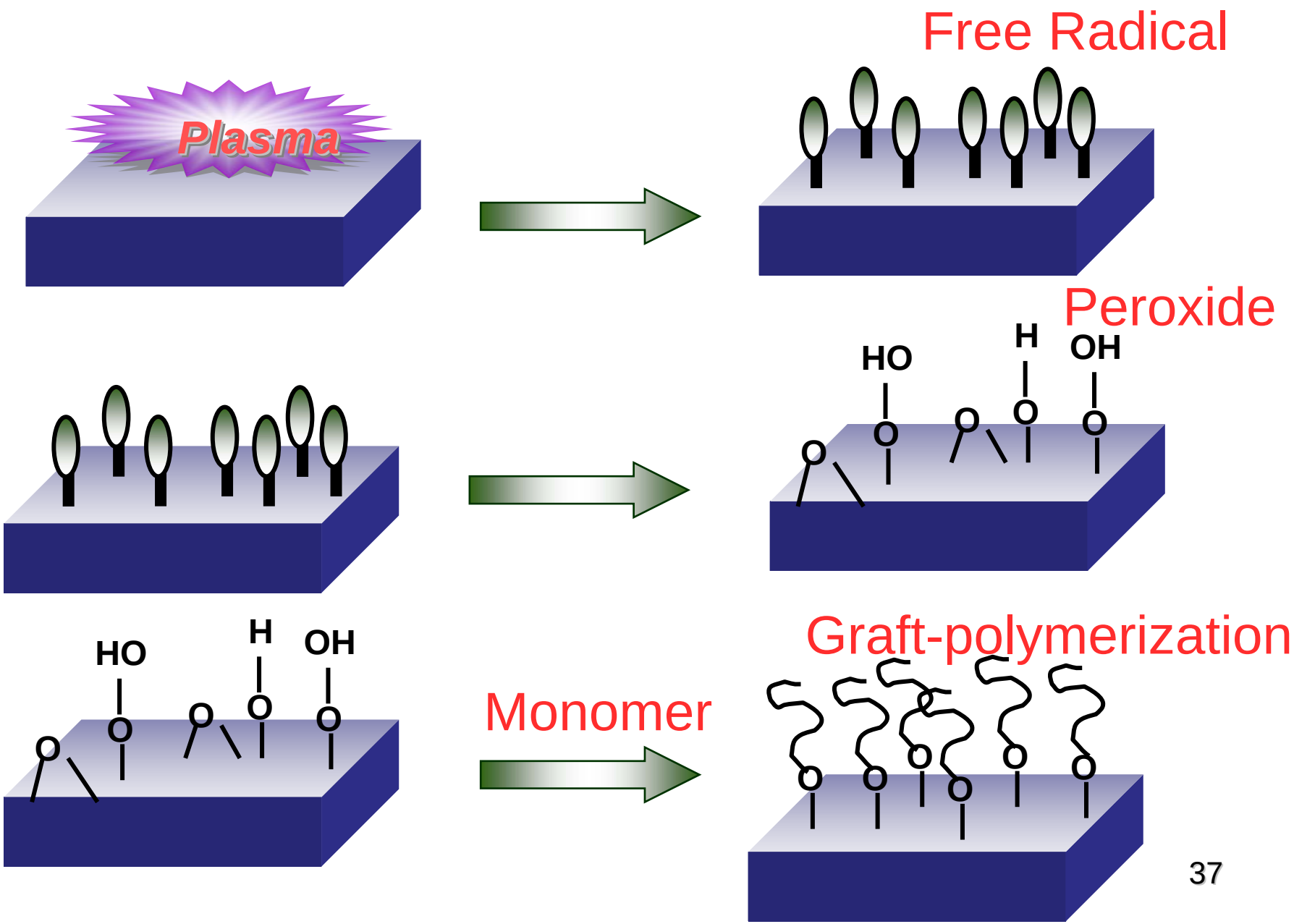

Stamp
Buffer
Waveguide
Antenna
Antenna Element
Quartz Plate
Plasma
Chamber

微波電漿工作原理

利用激發源所發射出的微波**(~ 2.45GHz)**電場能量，將其能量波藉由共振腔的傳遞導引至緩衝室**(buffer chamber)**內，透過陣列天線**(antenna array)**單元使其能量均勻分配至每一子陣列天線上，在導引至反應腔室的樣品處理面上。

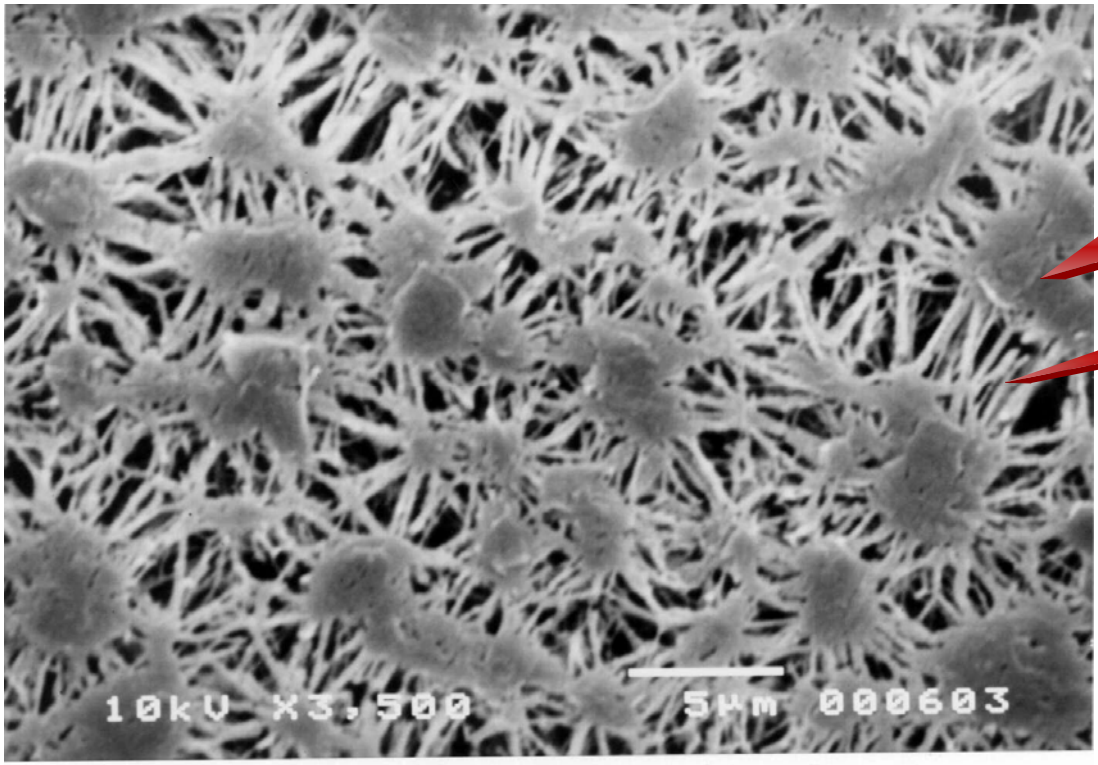
Modification

電漿誘發聚合反應



Expanded poly(tetrafluoroethylene)

利用雙軸延伸之方法，使得PTFE 在製造過程中產生多孔(micropore)性質之等方性材料(Isotropic Material)



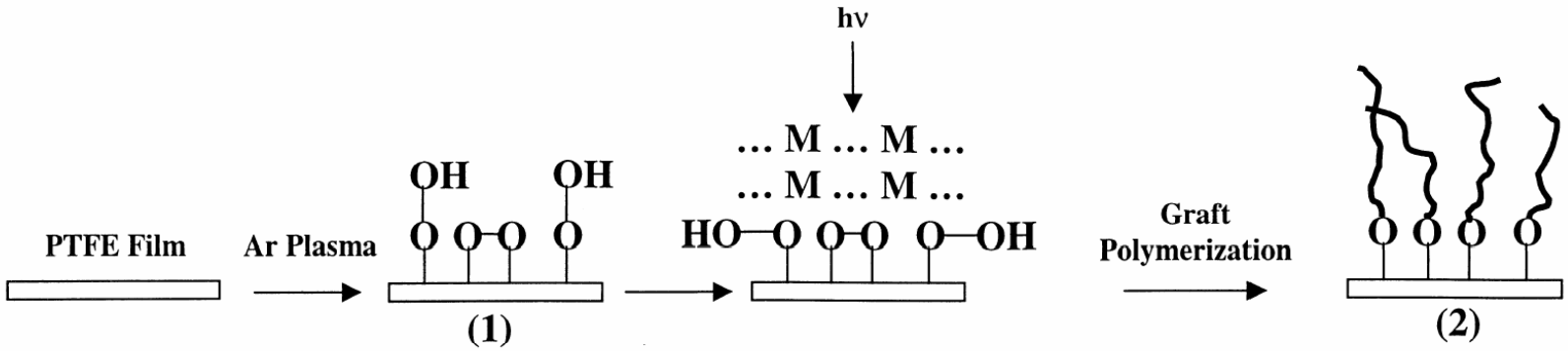
節結(nodes)

纖維(fibrials)

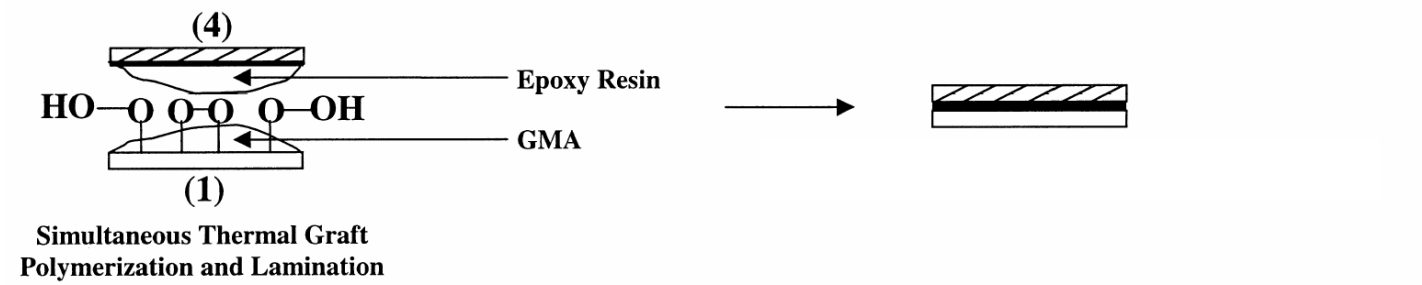
multi-directions

pore size 1.0~2.0um

Experiment



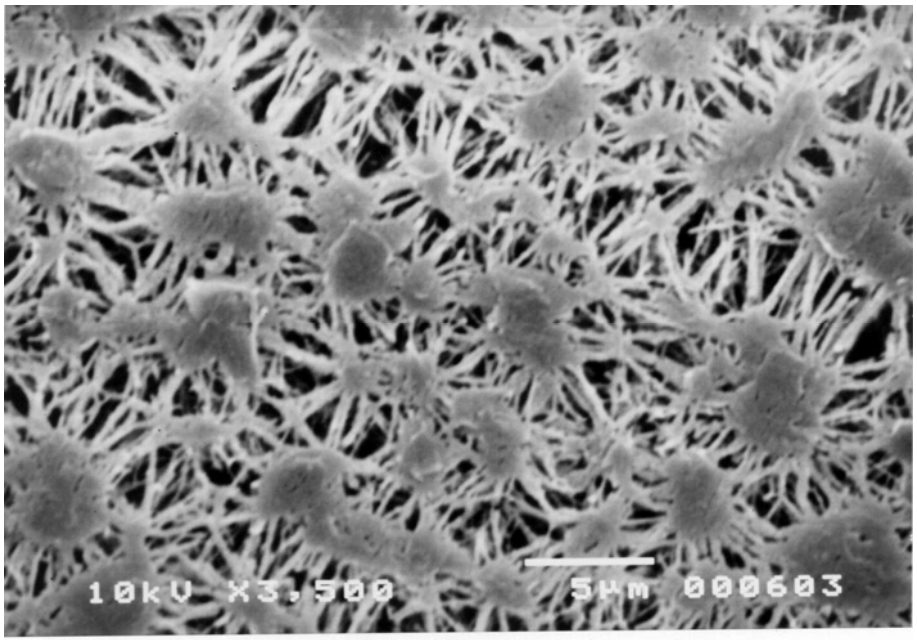
(a)電漿處理 & 反應性單體接枝共聚合反應



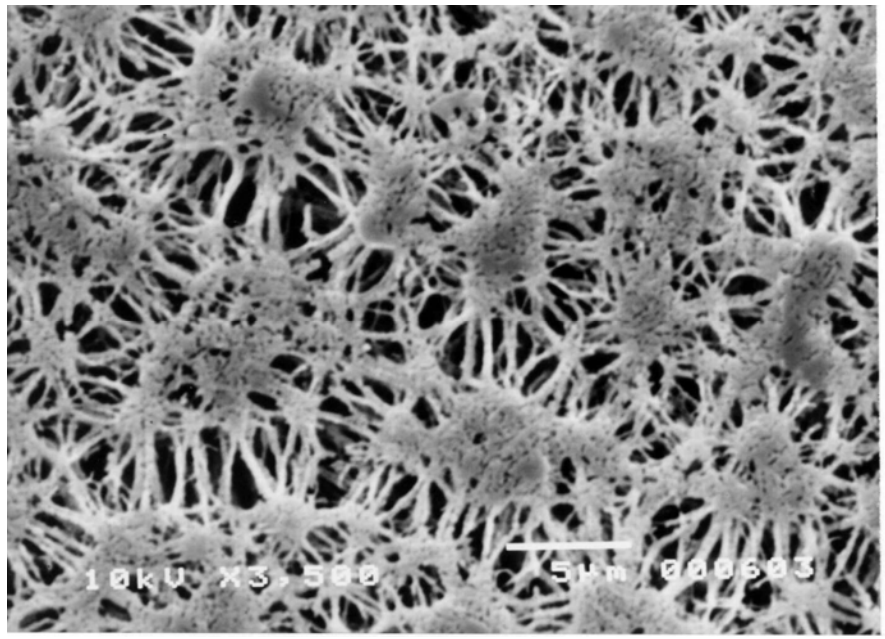
(b) ePTFE/Cu押合處理

Result and Discussion

SEM分析

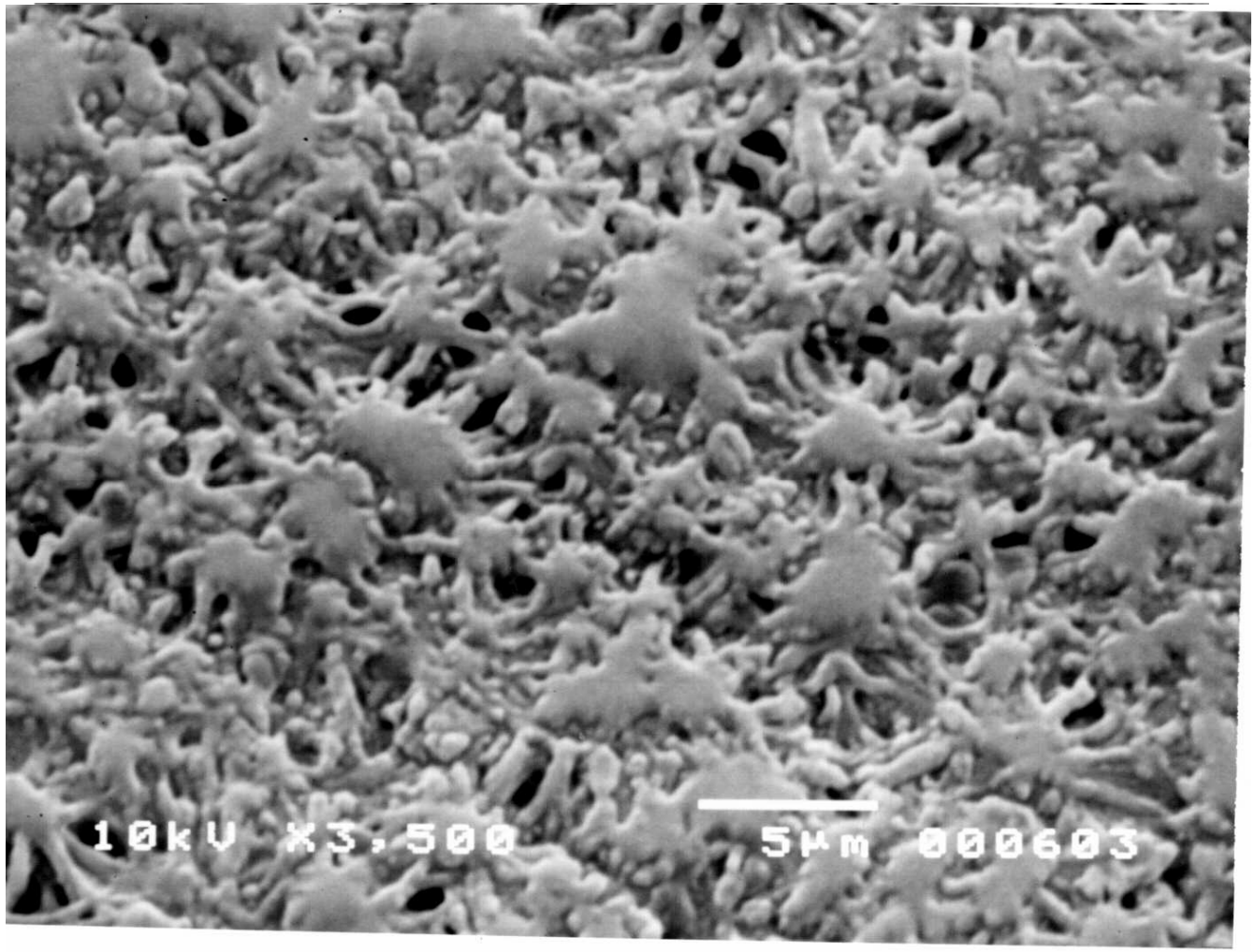


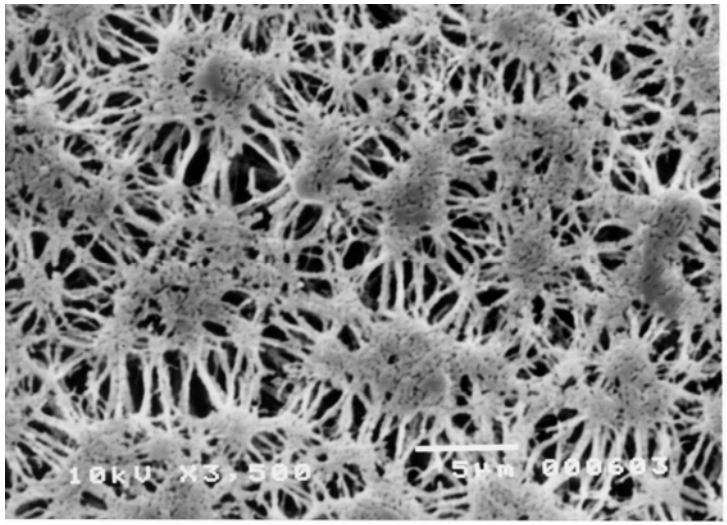
pristine e-PTFE



Plasma treatment

Graft Polymerization SEM分析





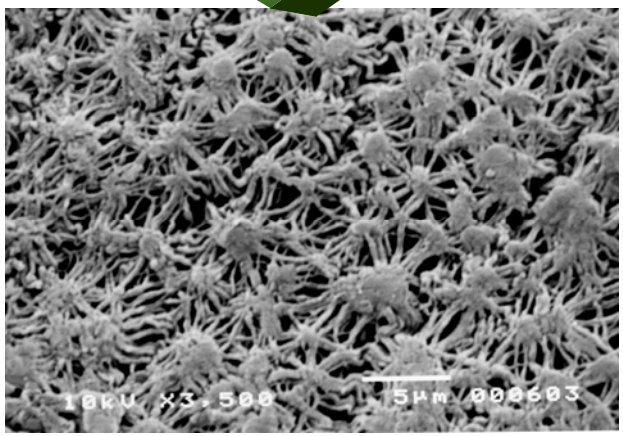
Plasma treated
e-PTFE

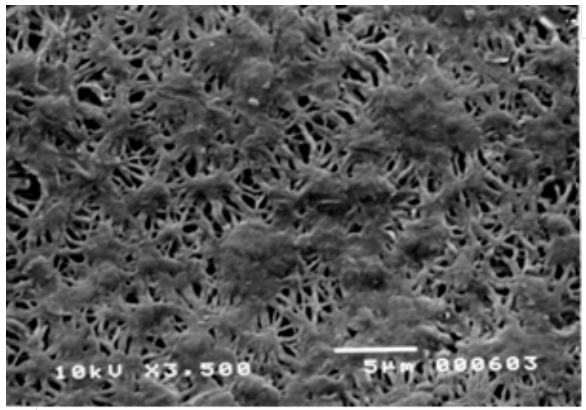
pAAc-grafted Polymerization

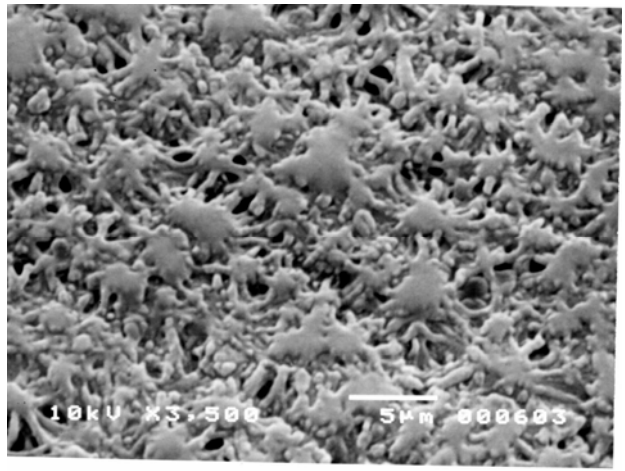
1hr

2hr

3hr





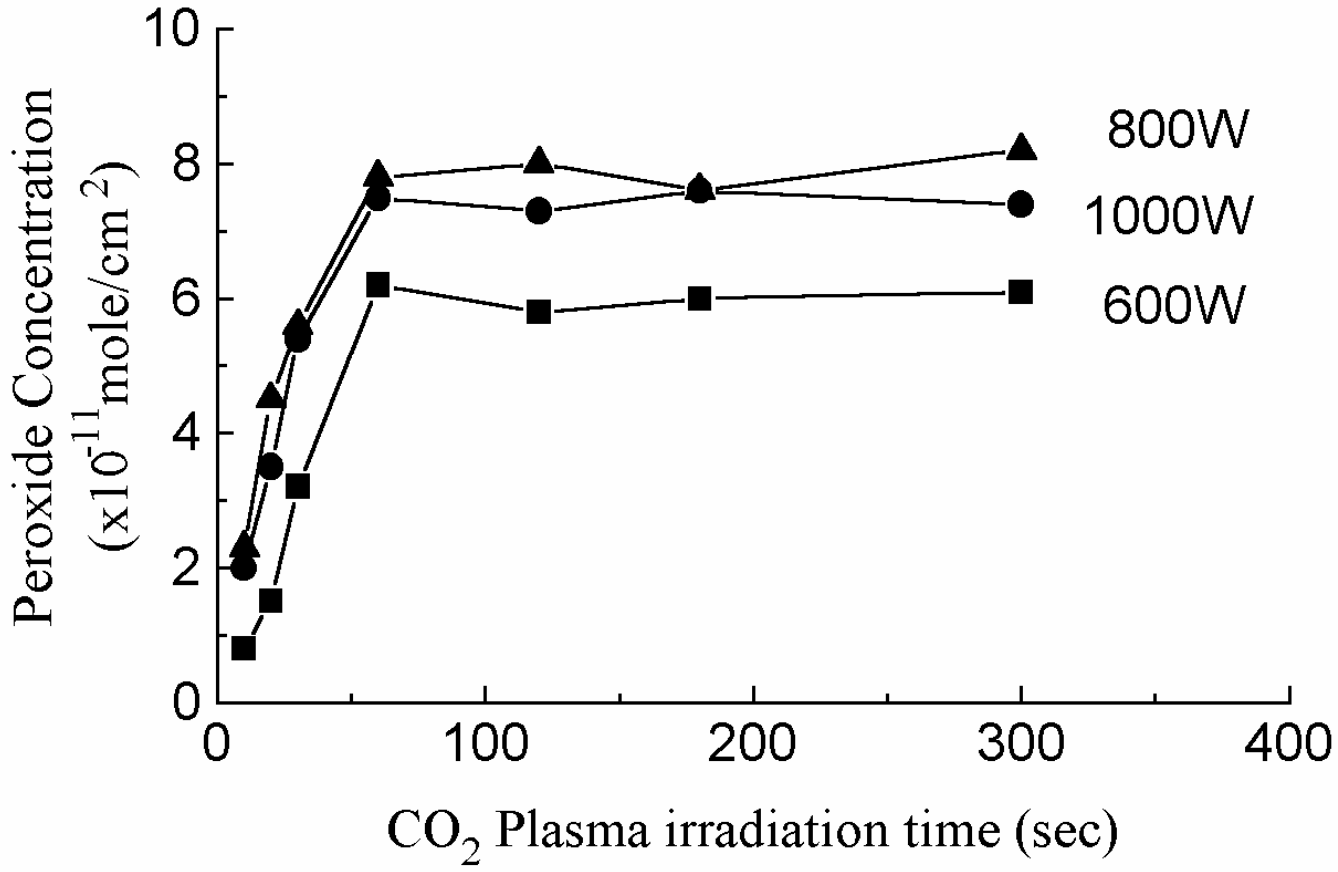


Parameters of Properties of Surface Exposed to Plasma

- **gas , substrate properties**
- **reaction conditions**

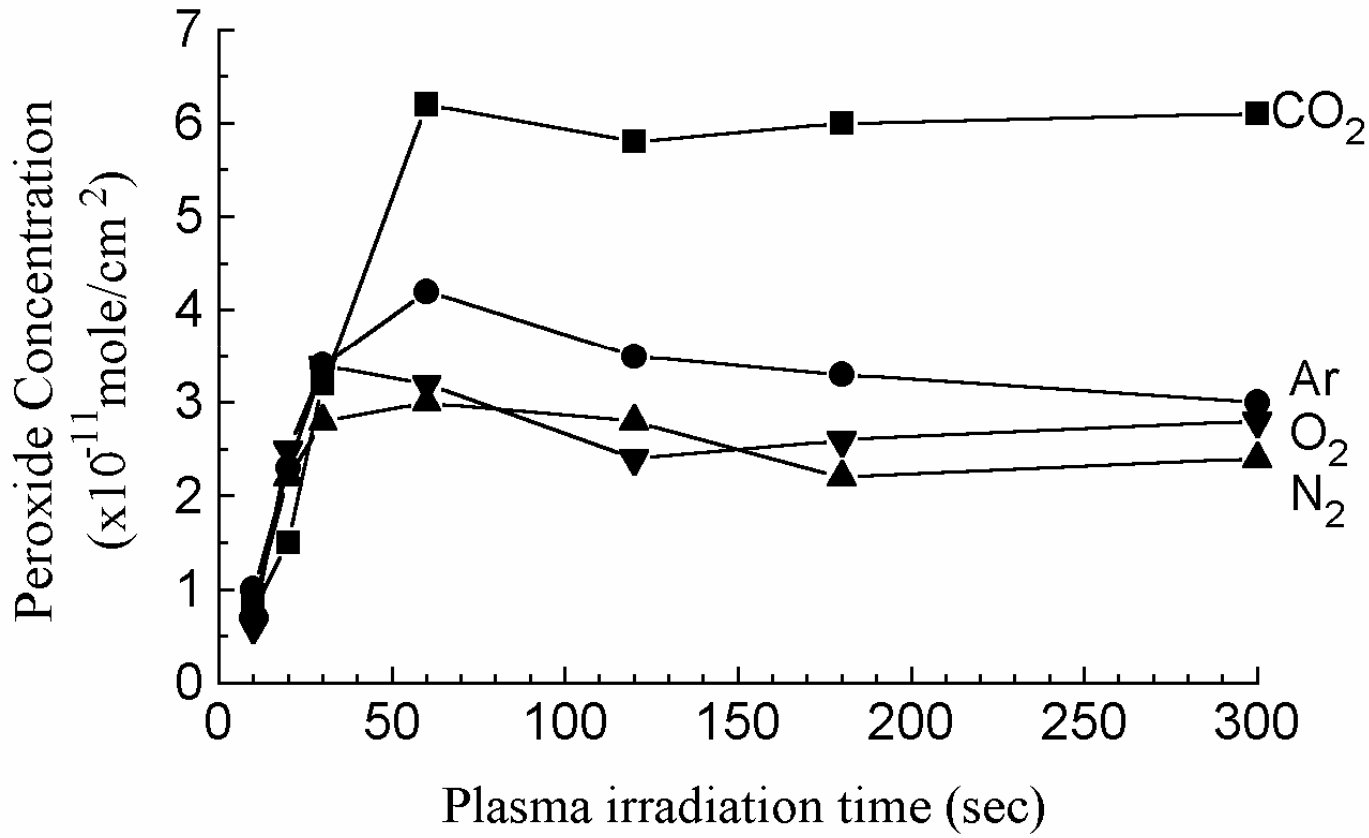
  -power , pressure , exposure time
- **reactor geometry**

電漿之功率對過氧化物濃度之影響



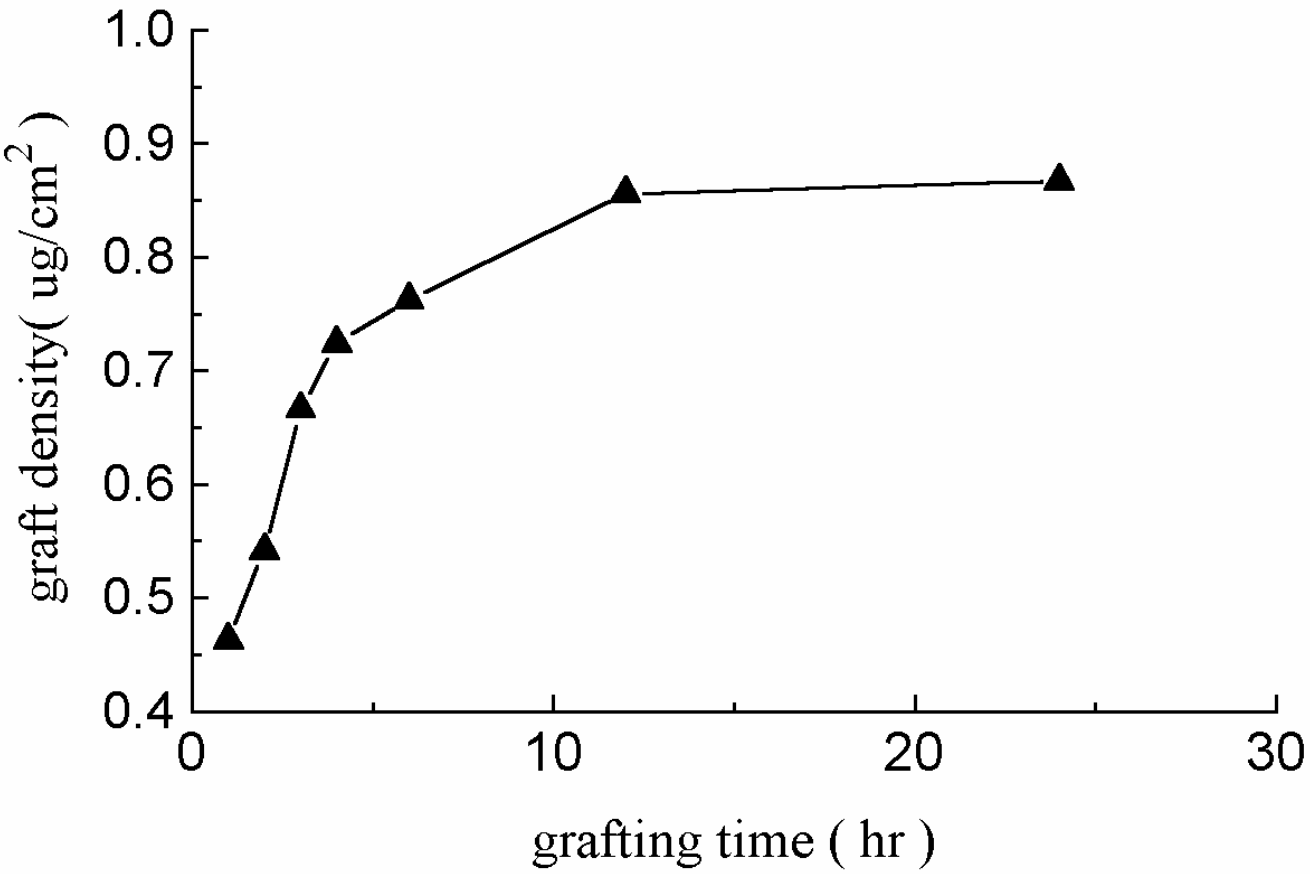
The peroxide concentration of ePTFE as funtions of microwave power and CO_2 plasma irradiation time.

不同氣體對過氧化物濃度之影響



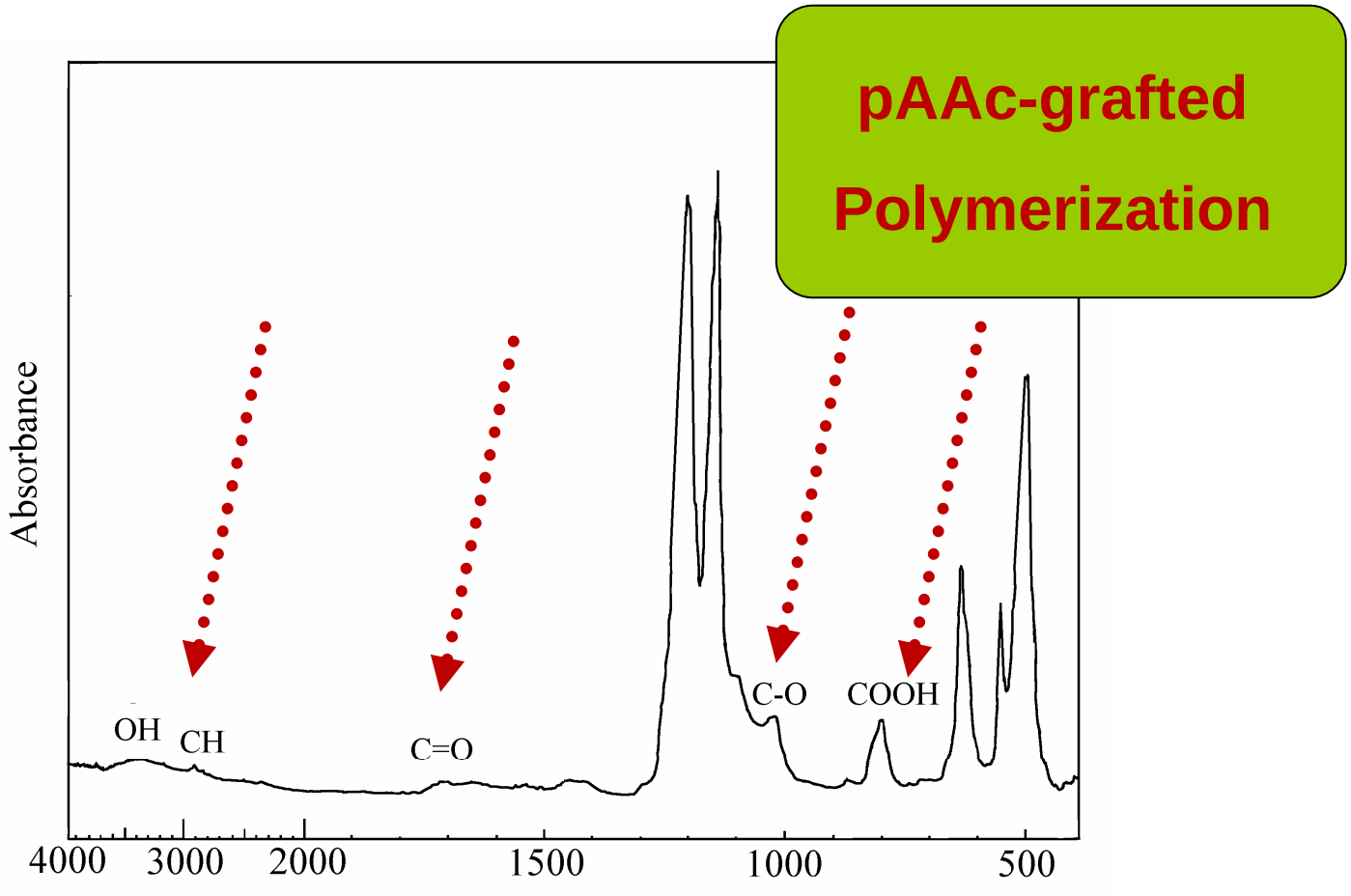
The peroxide concentration of ePTFE with CO_2, Ar, O_2, N_2 plasma pretreatment vs irradiation time.

The Graft Density of ePTFE



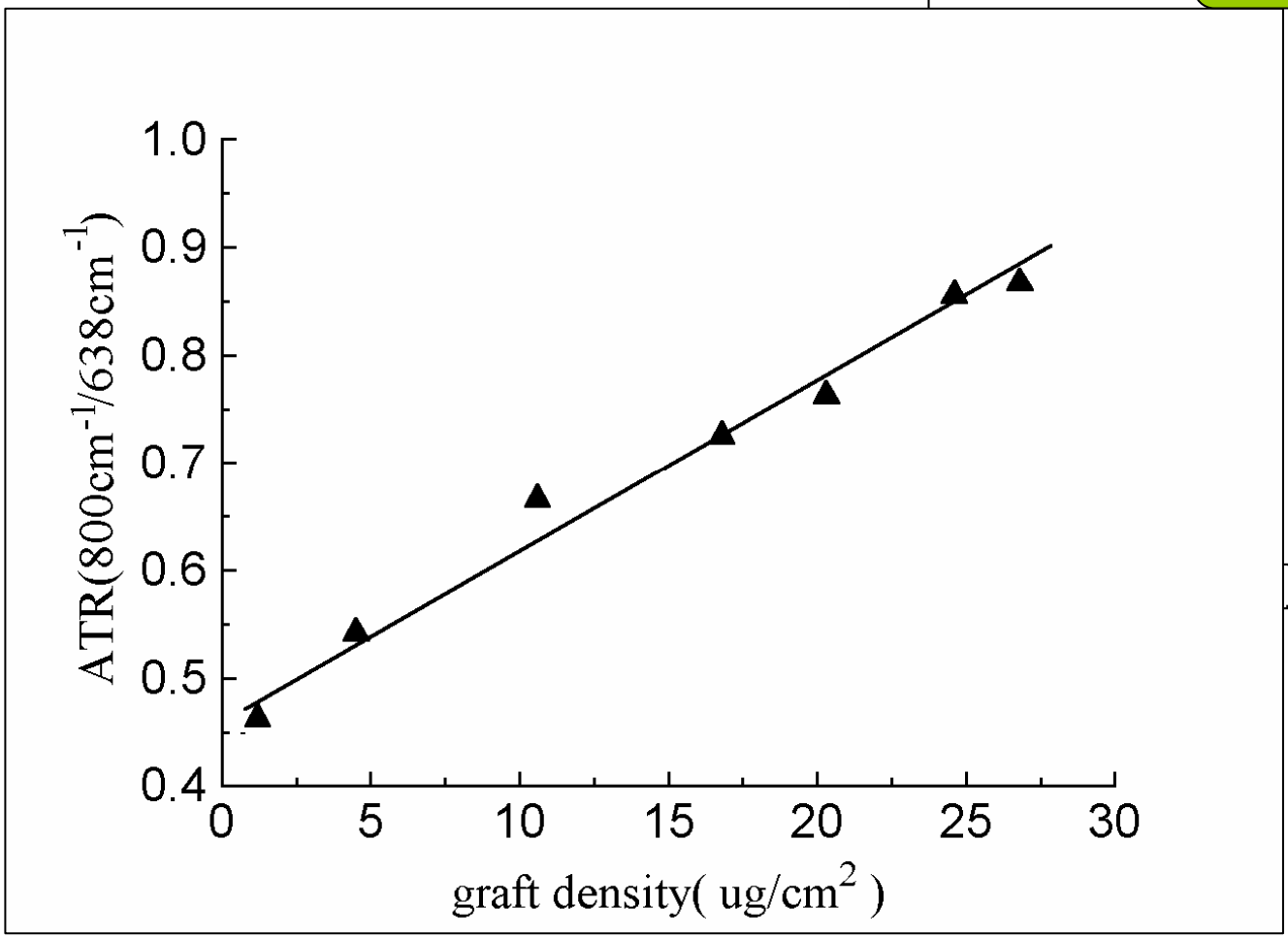
The plot of the graft density of the PAAc grafted ePTFE sheet vs. the graft time.

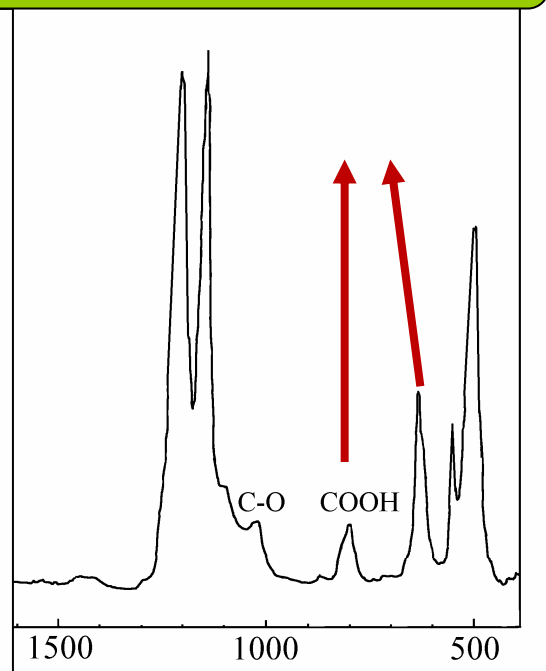
ATR-FTIR光譜分析



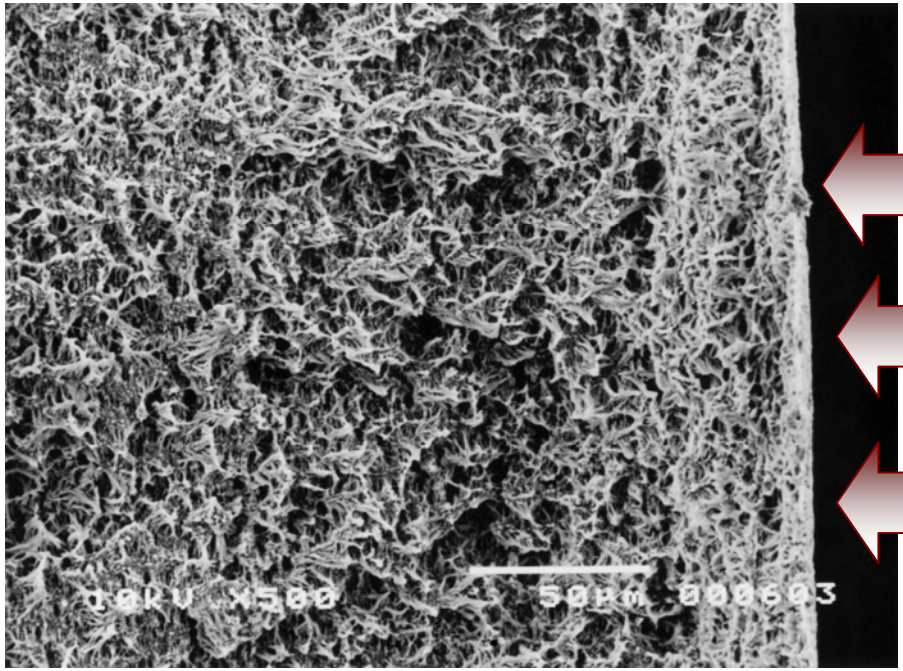
Absorption Ratio Estimated by the ATR-FTIR

800cm^{-1} / 638cm^{-1}

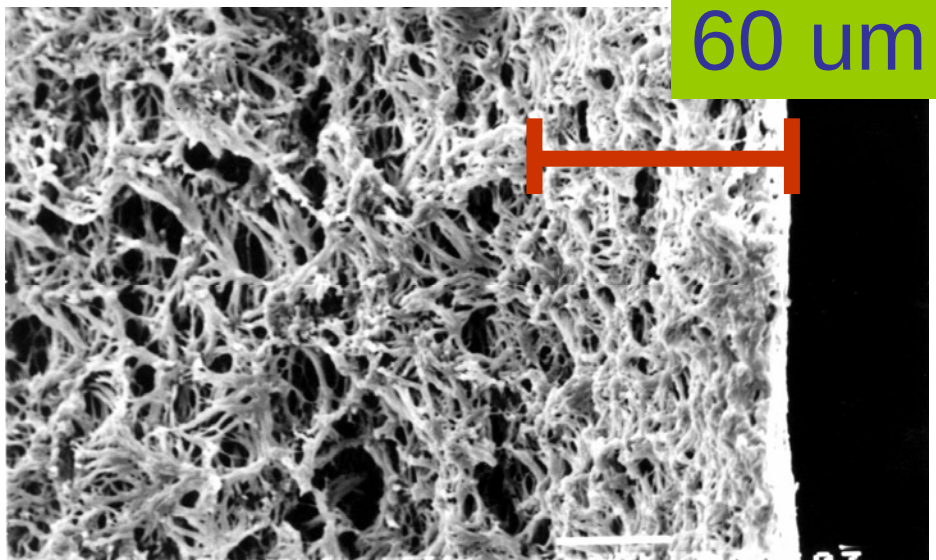




SEM斷面(cross-section)分析



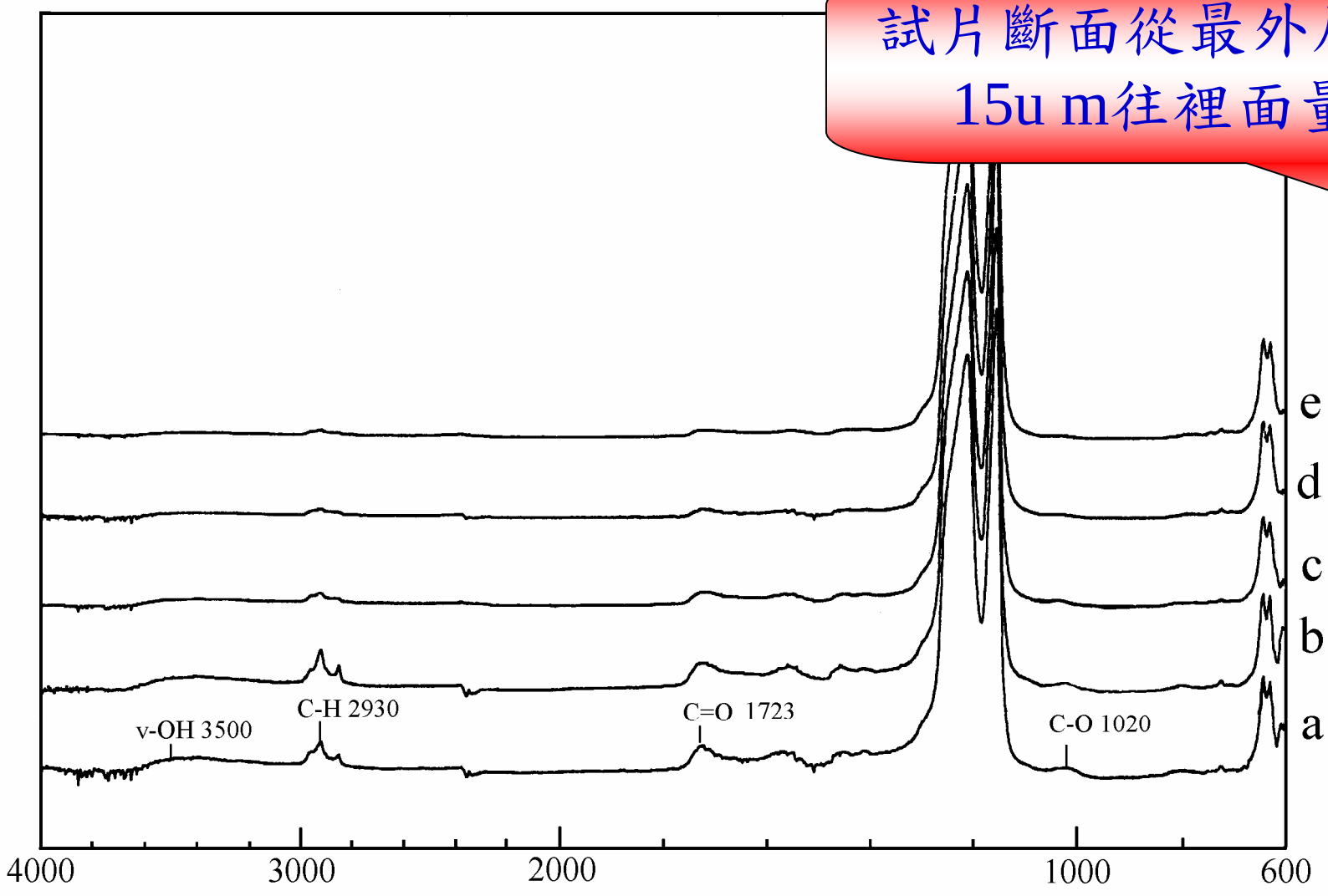
Grafting

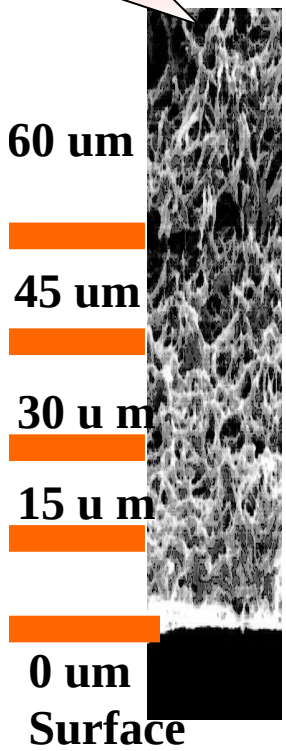


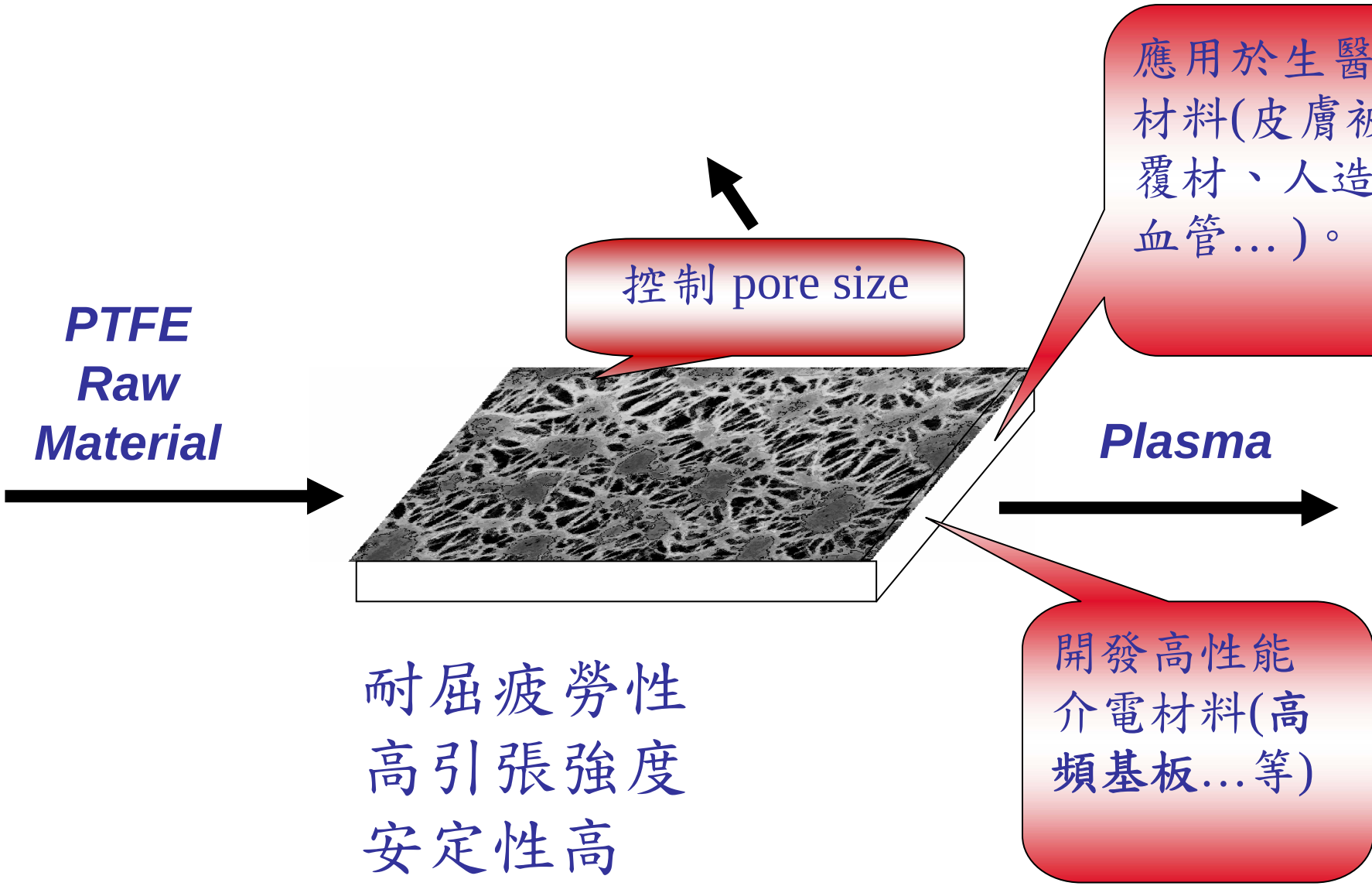
60 um

接枝聚合層的深度分析(FTIR microscopy)

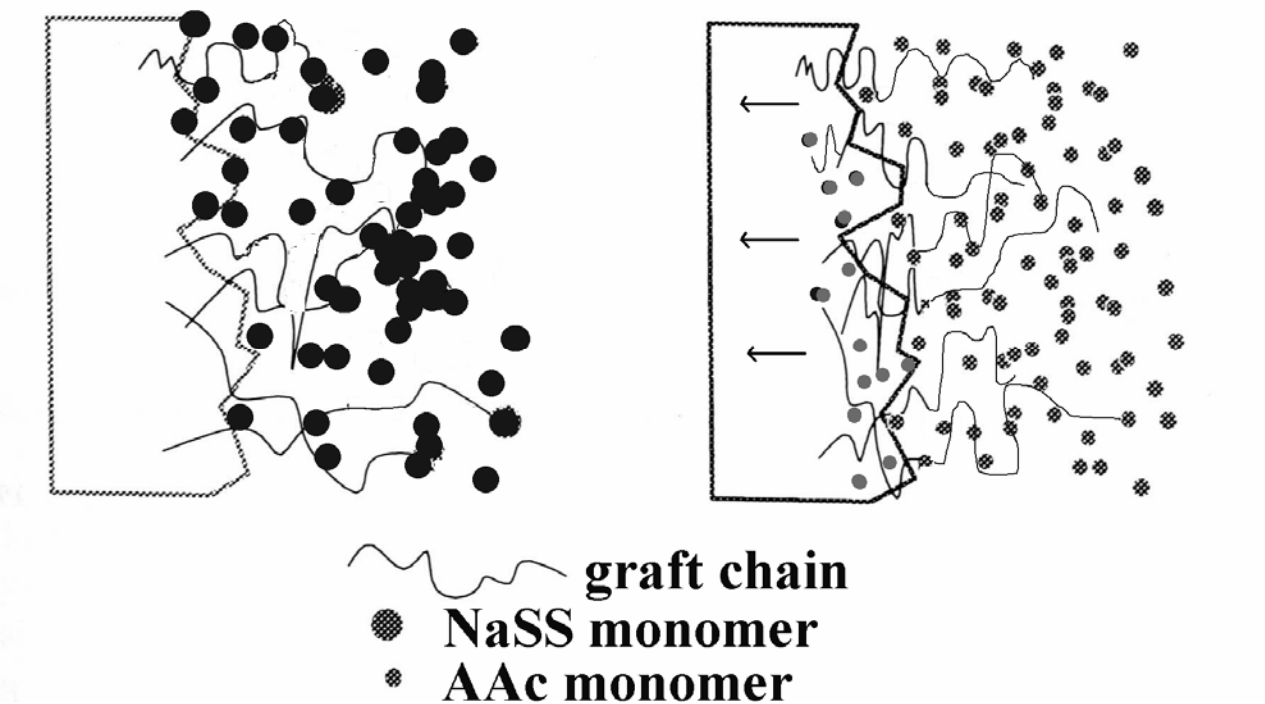
試片斷面從最外層每隔15u m往裡面量測






PTFE
Raw
Material
控制 pore size
應用於生醫材料(皮膚被覆材、人造血管…)。
Plasma
開發高性能介電材料(高頻基板…等)
耐屈疲勞性
高引張強度
安定性高
介電特性優良

單体進入之模型



AAc monomer 在migrate 的過程中，在靠近ePTFE表層部份由於較易形成接枝聚合物，因此，PAAc之含量較多AAc monomer進入ePTFE的裡層時，因為受逐漸堆積的PAAc接枝聚合物的影響而無法再進入ePTFE裡層，

Conclusion

1. ePTFE sheet高分子表面經由高離子化密度電漿處理後，在表面處會發生斷鏈，形成自由基態或極性之氧化物（或過氧化物）產生。利用自由基反應可使單體AAc接枝，形成具有親水性之表面。

2. 電漿前處理可在極短時間（數秒）使氟素高分子表面活化。

3. 利用此一能量導引方式來達到大面積的製程處理並改善特殊材料之黏著性，開發高性能介電材料(**高頻基板**...等)，生醫材料(例如皮膚被覆材、人造血管...等)。