Chapter 2

Condensation and Other Type Polymerization

- **Three categories of Polymerization process**

1. condensation, 2. addition, and 3. ring opening polymerization.

→ *Generally due to different monomer structure*

- **Two categories of Polymerization mechanism**

1. Step

2. Chain polymerization (addition + ring opening).

Generally due to different mechanistic path way

Step versus Chain

1. **Step: Monomer + Monomer → Dimer**

   Dimer + Monomer → Trimer

   Dimer + Dimer → Tetramer ……

   Chain: Chain growth takes places only at the end of a few initiated chains

2. **Step: a disappearance of monomer at an early stage**

   Chain: the monomer concentration decreases steadily

3. **Step: Molecular weight rises steadily**

   Chain: High Polymer is formed rapidly from each initiated monomer

Types of Condensation Reaction

- **The formation of polyester and polyamide;**

  The elimination of water or ROH or HCl

Mechanism of Condensation Polymerization

Addition – elimination reaction

Stabilized by catalysts such as *metal cations, protonic, or Lewis acid*

Requirement for High molecular weight;

Exact 1:1 ratio of the two functional groups (see ch. 11)

Scrambling reaction

Ring Formation versus Polymerization

- ***Details in chap 10***

Linear Polyesters

Polyesters

고분자필름 사이에는 공기가 통과할 정도의 구멍이 존재한다.

Branched and Crosslinked Polyesters

Polycarbonate

Bubbling phosgene gas into a solution of bisphenol A in pyridine at 25 – 30 °C

phosgene is a toxic gas

Use trichloromethyl chloroorthoformate; It decompse into two phosgenes in the reaction

자동차 램프로 유리대신 고분자를 사용하는 이유

Polyanhydride

Unstable to moisture; drug delievery

고분자를 이용한 약물 전달 체계

Polyamides; nylon

Four Major synthetic procedures; 1. Melt polymerization, 2. Dehydration-condensation of aminoacid, 3. The reaction between diacid chloride and a diamine, 4. Ring opening polymerization (Chap. 6)

1. Melt Polymerization

1:1 salt is prepared first, then heated to 195 ^{o}C then 215 ^{o}C, finally 275 ^{o}C. (MP of Nylon 66 is 267 ^{o}C)

Nylon 66 means 6 carbons at diamine and 6 carbons at diacid

2. Polymerization of amino acid

11-aminoundecanoic acid (H_2N-$(CH_2)_{10}$-COOH) at 220 ^oC under vacuum or by a stream of inert gas to produce Nylon 10

or

Preparation of polypeptide using dicyclohexylcarbodiimide as a dehydrating agent

3. Interfacial Polymerization

Aromatic Polyamide; aramide

para-phenylene diamine + terephthaloyl chloride
(Interfacial polymerization)
= kevlar

Bullet proof vests, helmets, tire-cord for airplane .....

Aramid fiber

Light weight
High strength
High modulus
Heat resistance

Polyimide

Non-soluble,
high thermal &
chemical stability

aromatic diamine + aromatic dianhydride
→ poly amic acid → polyimide

Machined device, electric device, coating for electronic devices (LCD)

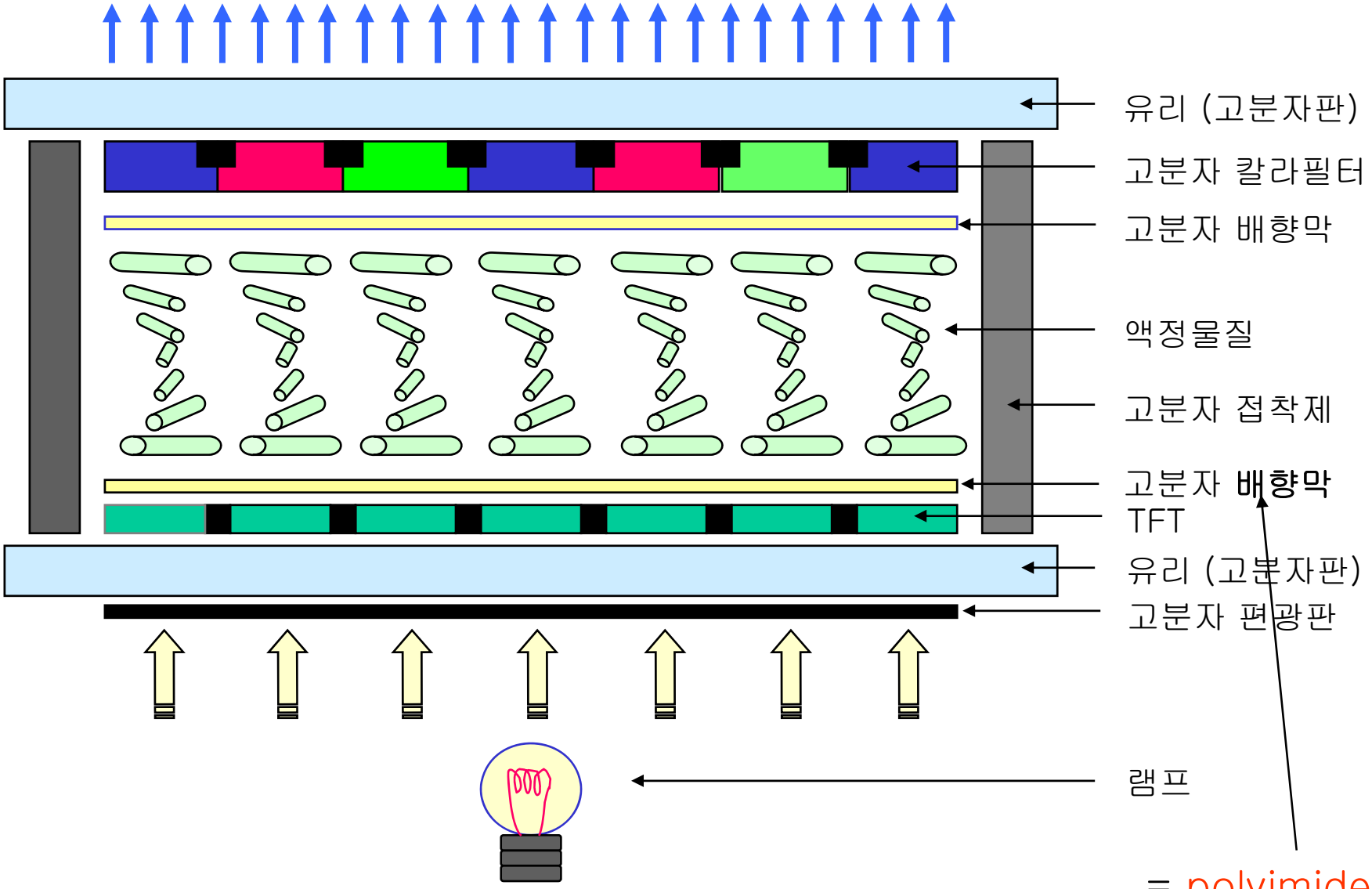

그림 12 액정디스플레이 모식도

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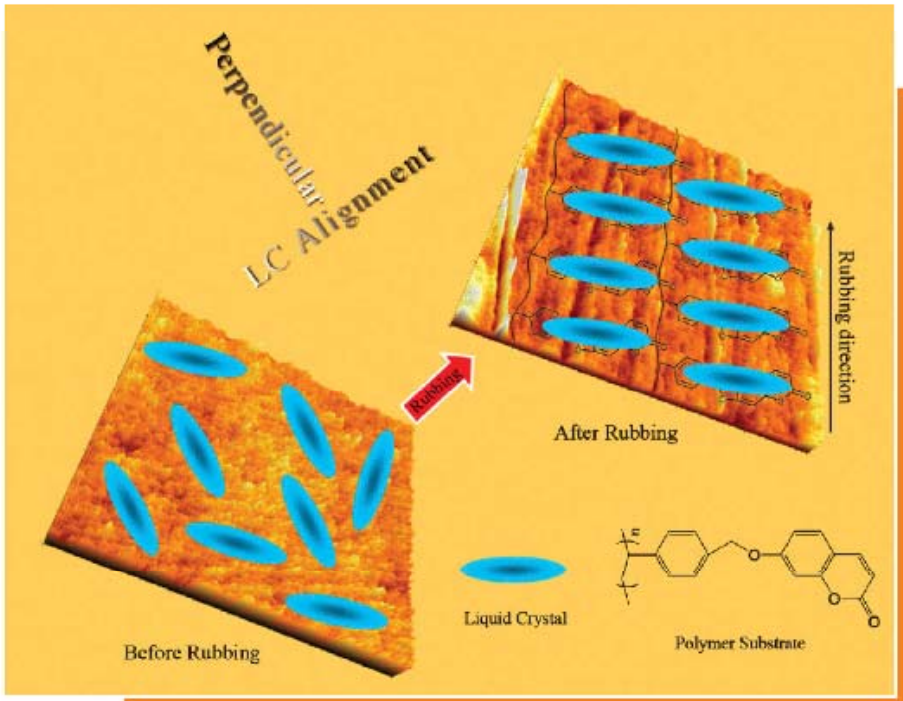
Macromolecular Chemistry and Physics

Founded by Hermann Staudinger



17/2007

1807 WILEY 2007

WILEY-VCH

Enhanced, Perpendicular Liquid-Crystal Alignment on Rubbed Films of a Coumarin-Containing Polystyrene (p 1853-1861)
Hyo Kang, Ki-Sun Kwon, Daeseung Kang, Jong-Chan Lee
Published Online: 21 Aug 2007
DOI: 10.1002/macp.200700270
Abstract | References | **Full Text:** HTML, PDF **(Size: 198K)**

액정 디스플레이 부품 (Backlight)

PET: 빛을 산란시켜 균일한 빛 발산시키며 외부 영과 scratch 방지

PC, PMMA,PET: 확산시료에서 방출된 빛을 모아 휘도를 향상

PET,PC/PMMA: 빛 을 산란시켜 균일한 빛 발산

PMMA: 램프의 선광, 면광화 함

PET/AI: 램프광을 액정 cell 방향으로 집중시켜 빛을 손실을 방지

POLYCALBONATE:램프, 도광판, 각종 시트류를 고정시킴

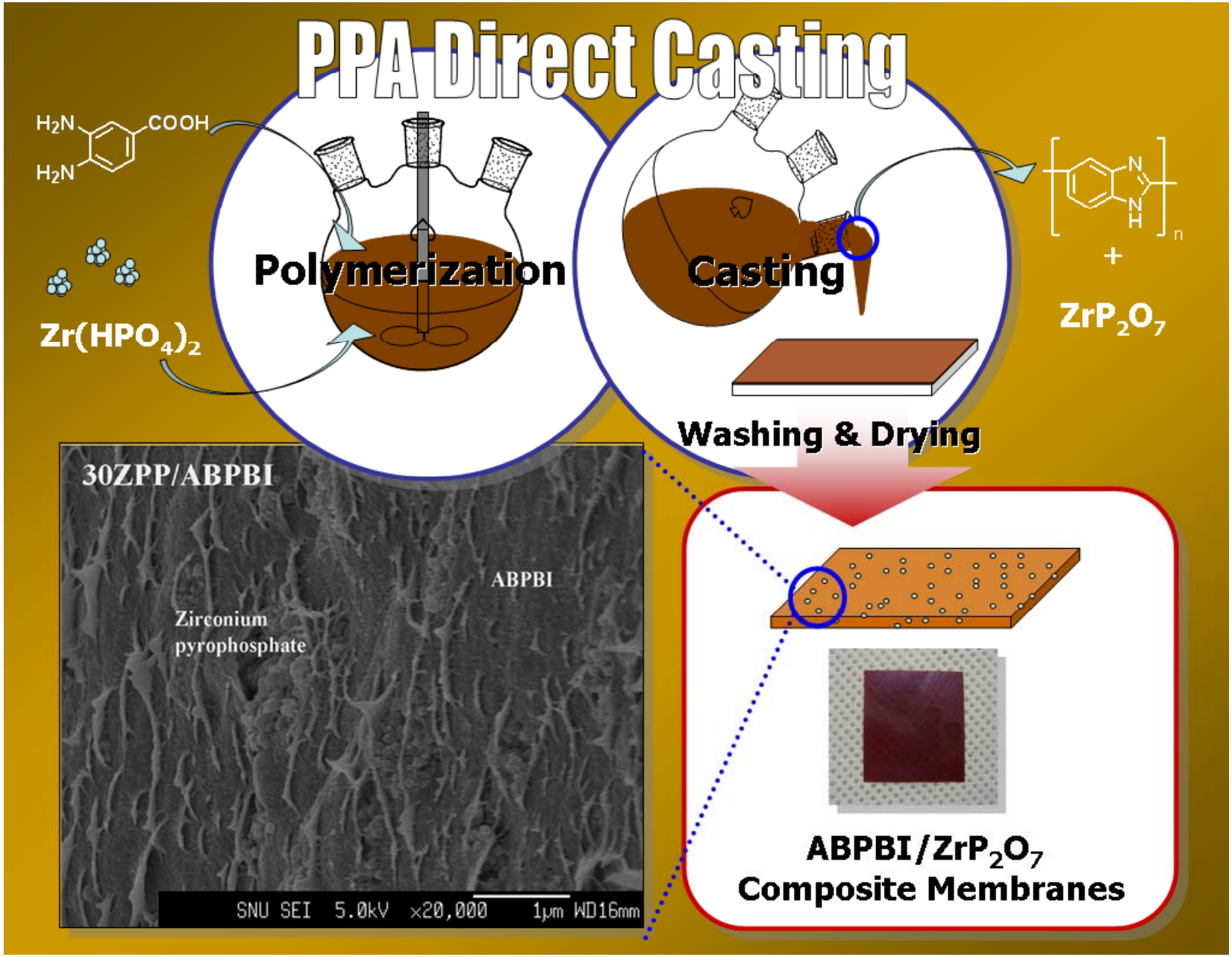
Polybenzimidazoles

Fuel Cell membrane, vests for fire fighters and spacemen

연료전지의 모식도

연료전지

Fuel Cells are electrochemical devices that convert a fuel's energy directly to electrical energy.


PPA Direct Casting
H2N
COOH
H2N
Zr(HPO4)2
Polymerization
Casting
Washing & Drying
+
ZrP2O7
30ZPP/ABPBI
ABPBI
Zirconium
pyrophosphate
SNU SEI 5.0kV ×20,000 1μm WD16mm
ABPBI/ZrP2O7
Composite Membranes

Polybenzoxazoles and Polybenzthiazoles

Polyquinoxalines

Aromatic ladder polymer

Phenol-formaldehyde polymers

Low temperature mixing of phenol and form aldehyde produces methylphenols, prepolymer

Heating to 105 °C produces cylco-linear or branched polymer; low MW, moldable

Higher temp (>105 °C) produces thermosets

Urea-formaldehyde polymers

Melamine-formaldehyde polymers

Polyacetal

Long chain diols are normally used to prevent the formation of cycles

Polyethers by aromatic Substitution

Polyethers by Oxidative Coupling Reactions

Diels-Alder Addition Polymers

Polyurethanes

Elastmer (for spandex or foam), coating (painting), adehesives.

X-linking is always possible

Polyureas