

Normally transparent polymer dispersed liquid crystal mode using the synthesis of Waterborne Polyurethanes

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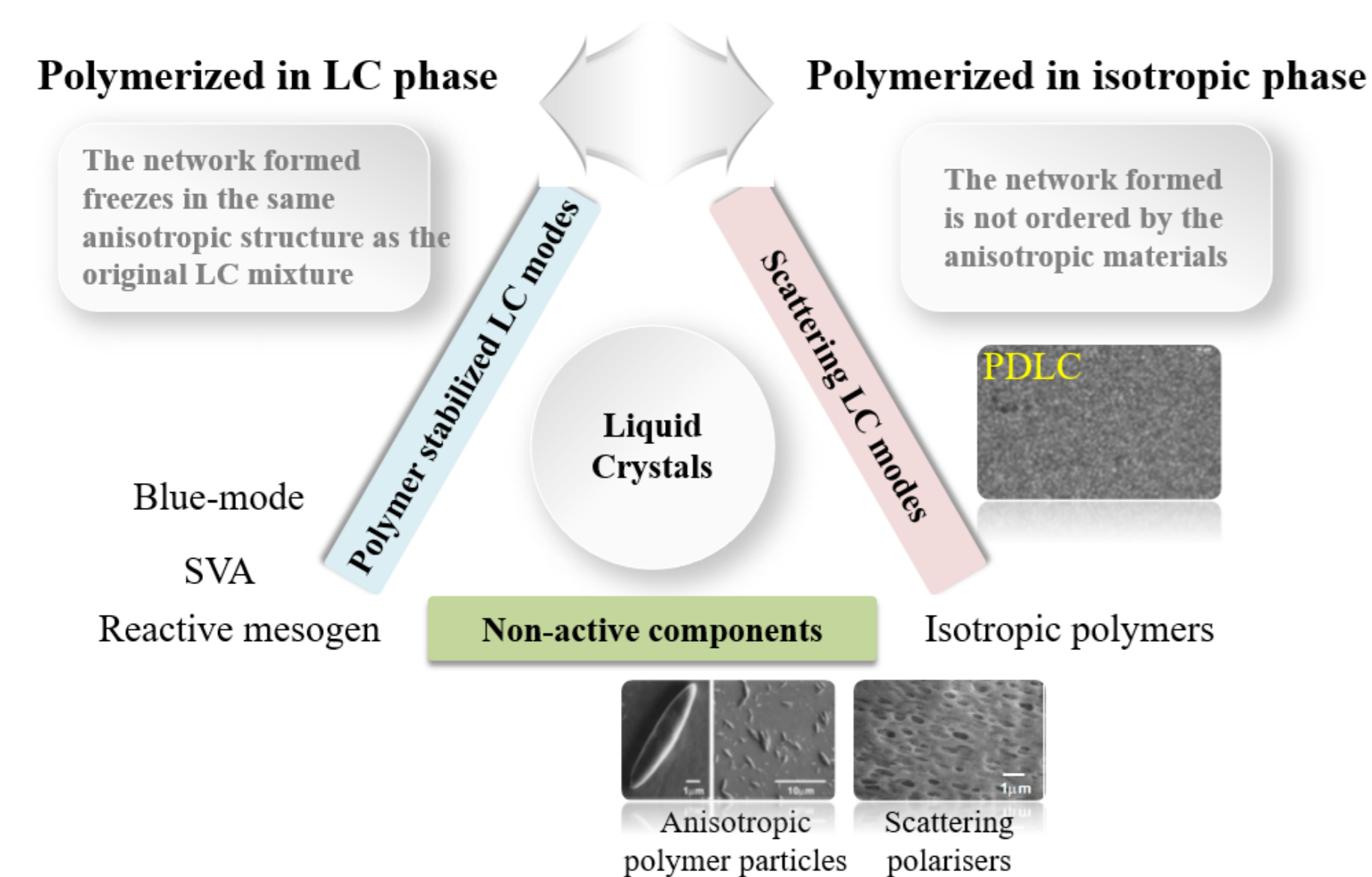
Abstract

Waterborne polyurethanes (WPU) with LC were successfully prepared using polycaprolactone diol and 4,4'-Methylene dicyclohexyl diisocyanate as soft segment of prepolymer, dimethylolbutanoic acid as emulsifier, and trimethylamine as neutralizer, ethylenediamine as chain extender based on different molecular weight of pre-polymer. Synthesized WPU prepolymer and liquid crystals were stirred under the constant rate. And de-ionized water containing bis(hexamethylene)triamine was added in the reaction mixture to form the polyurea. In this study, it is the control of confirmed microcapsule size by adjusting the molecular weight of the prepolymer. The molecular weights and the functional groups of the WPUs are evaluated through the GPC and FT-IR. Microcapsule LC complexed WPUs could be applied to the various industry fields of next-generation display, such as 3D printer material, smart window and flexible display

Keywords: waterborne polyurethanes, polymer dispersed liquid crystal.

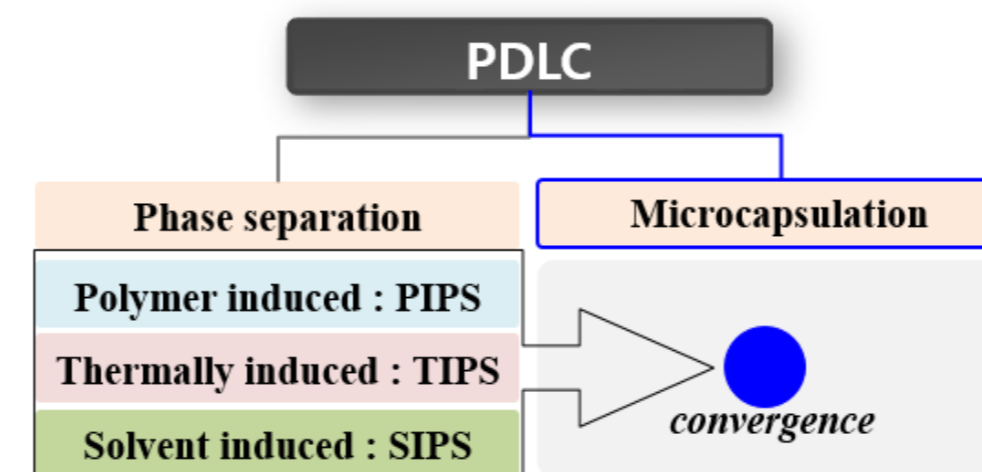
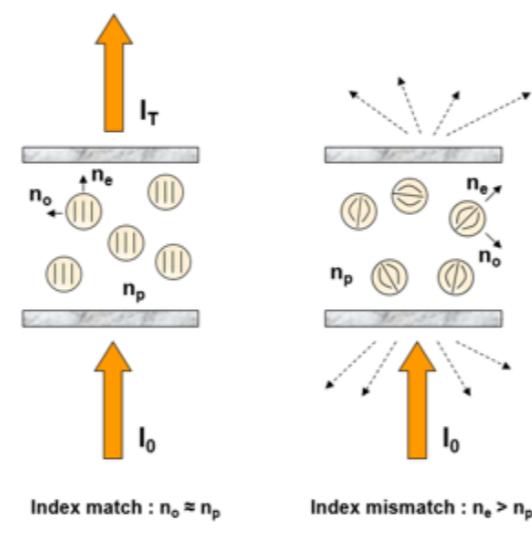
Introduction

Polymers and Liquid Crystals



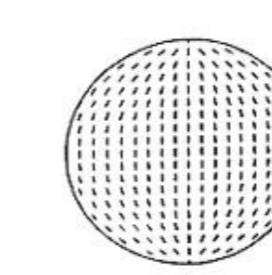
PDLC Tech. (Smart Window)

Conventional polymer dispersed liquid crystal film consist of a thin film of polymer that contains micron-sized droplets of a nematic liquid crystal. In the undriven state, the liquid crystal director in the nematic droplets has no preferred orientation with respect to the plane of the film. The film therefore appears opaque. When an electric field is applied to the film, the nematic liquid crystal in the droplets reorients so that the director is parallel to the field, and therefore perpendicular to the plane of the film. If the ordinary refractive index of the liquid crystal is matched to the refractive index of the polymer, then light incident normal to the film does not encounter any variation in refractive index, and passes through the film without being scattered. Such films are therefore opaque in the off state but become clear when a voltage is applied. From the power consumption in the smart window field, research on normally transparency PDLC is very important.



Key technology is the control of droplet size

for a bipolar configuration LC



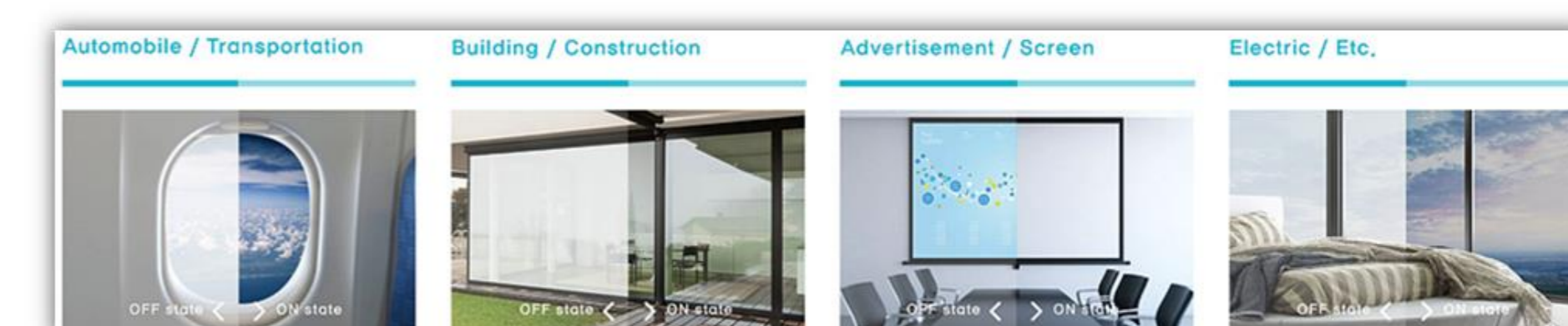
R: Average droplet radius,
L: Droplet aspect ratio(R1/R2)
d: Cell gap
K: Elastic constant
E0: LC dielectric permittivity
 $\Delta\epsilon$: LC dielectric anisotropy

$$V_{on} = \frac{d}{R} \sqrt{L^2 - 1} \sqrt{\frac{4\pi K}{\Delta\epsilon}}$$

$$V_{th} = \pi \sqrt{\frac{K_1}{\Delta\epsilon}}$$



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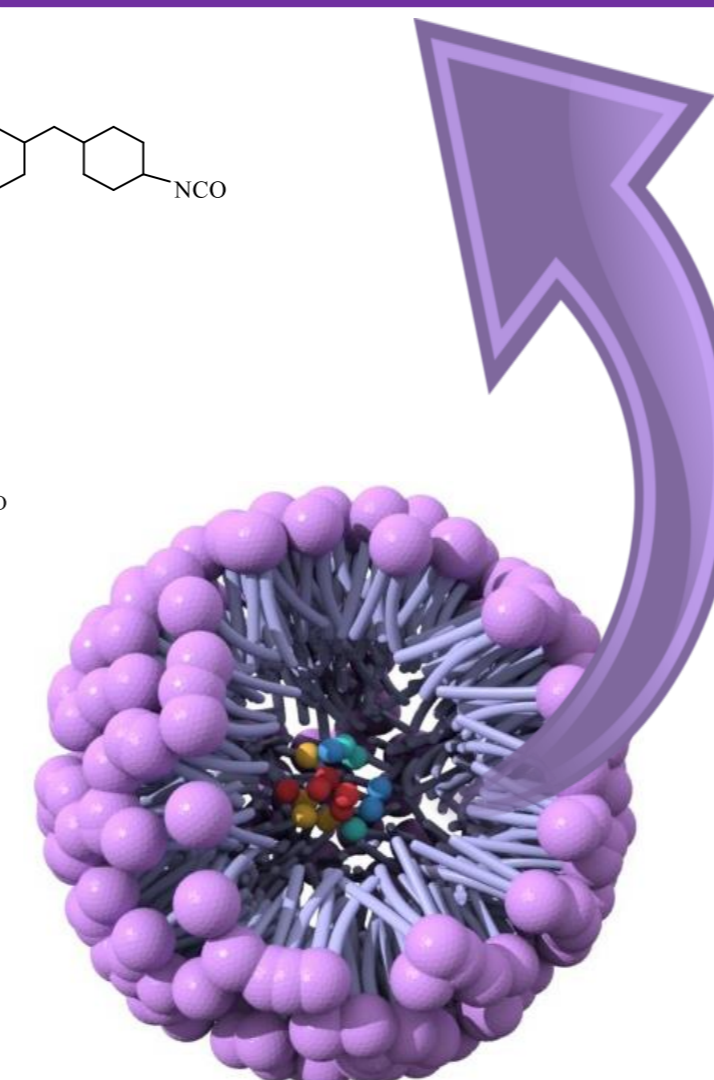
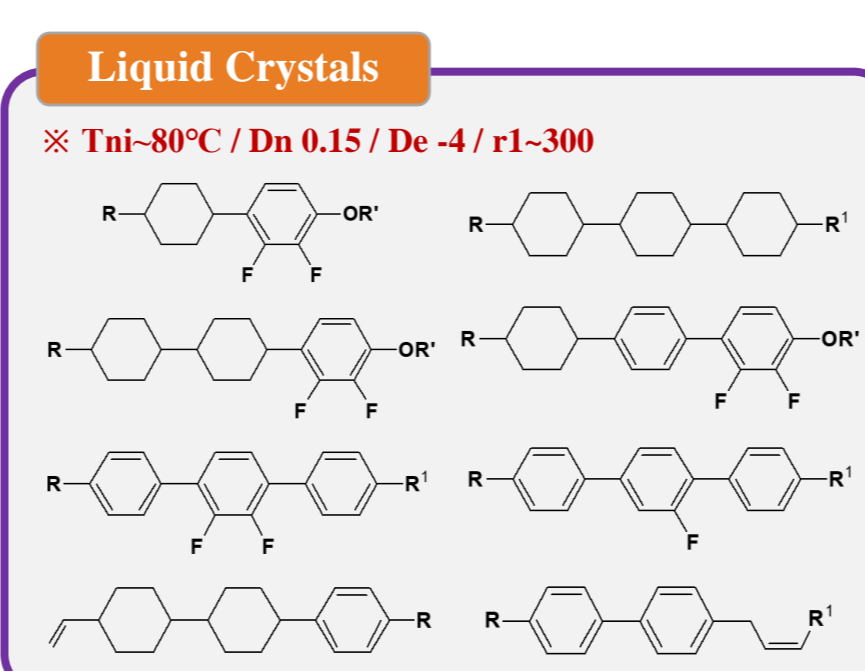
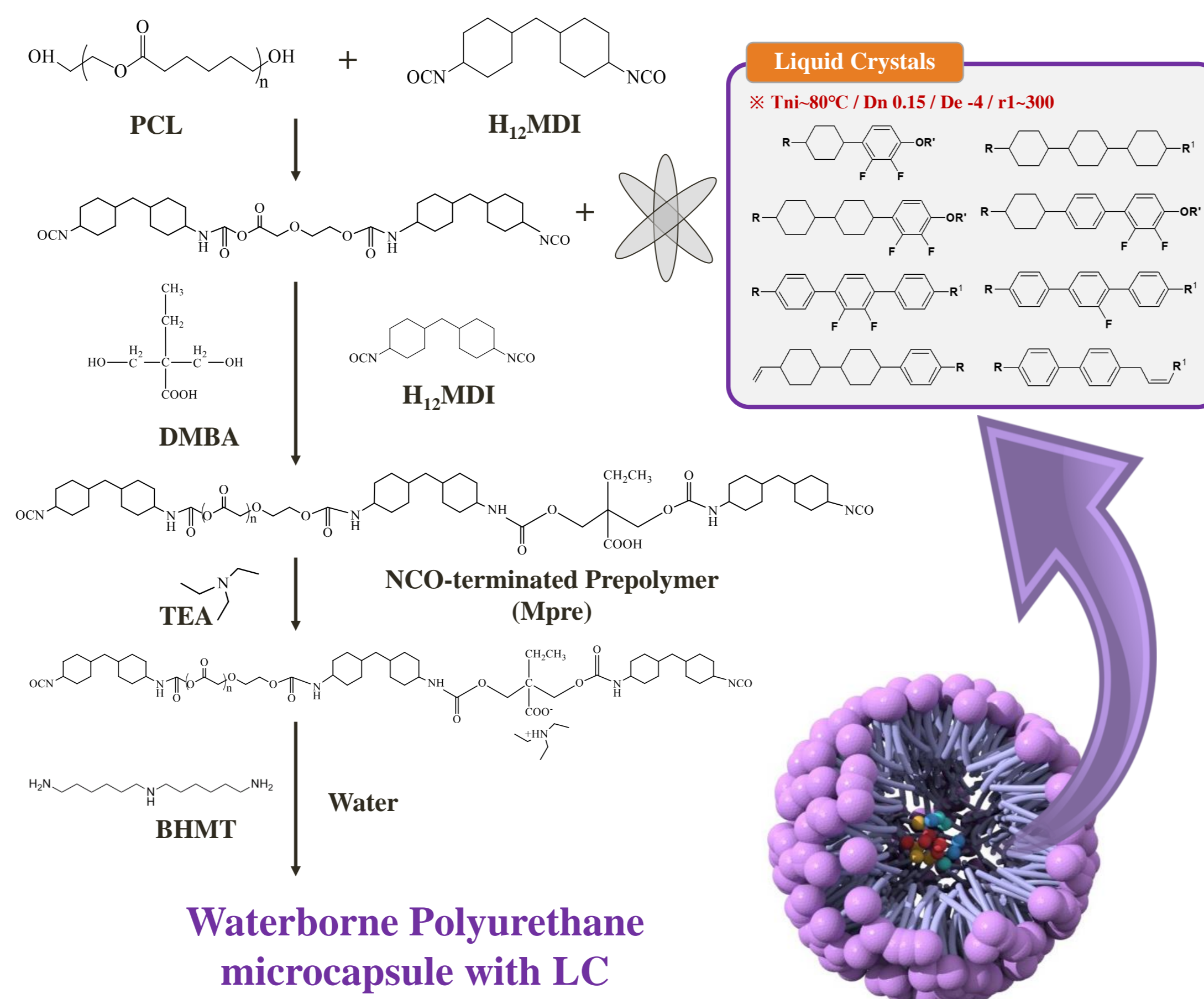


Experimental

Materials

- Polyol : PCL (polycaprolactone)
- Isocyanate : H₁₂MDI (4,4'-Methylene dicyclohexyl diisocyanate)
- emulsifier : DMBA (dimethylolbutanoic acid)
- neutralizer : TEA (trimethylamine)
- Cross-linker: Bis(hexamethylene)triamine
- LC : Negative LC
- RM : photoreactive methacrylate groups
- SAM : Self alignment monomer

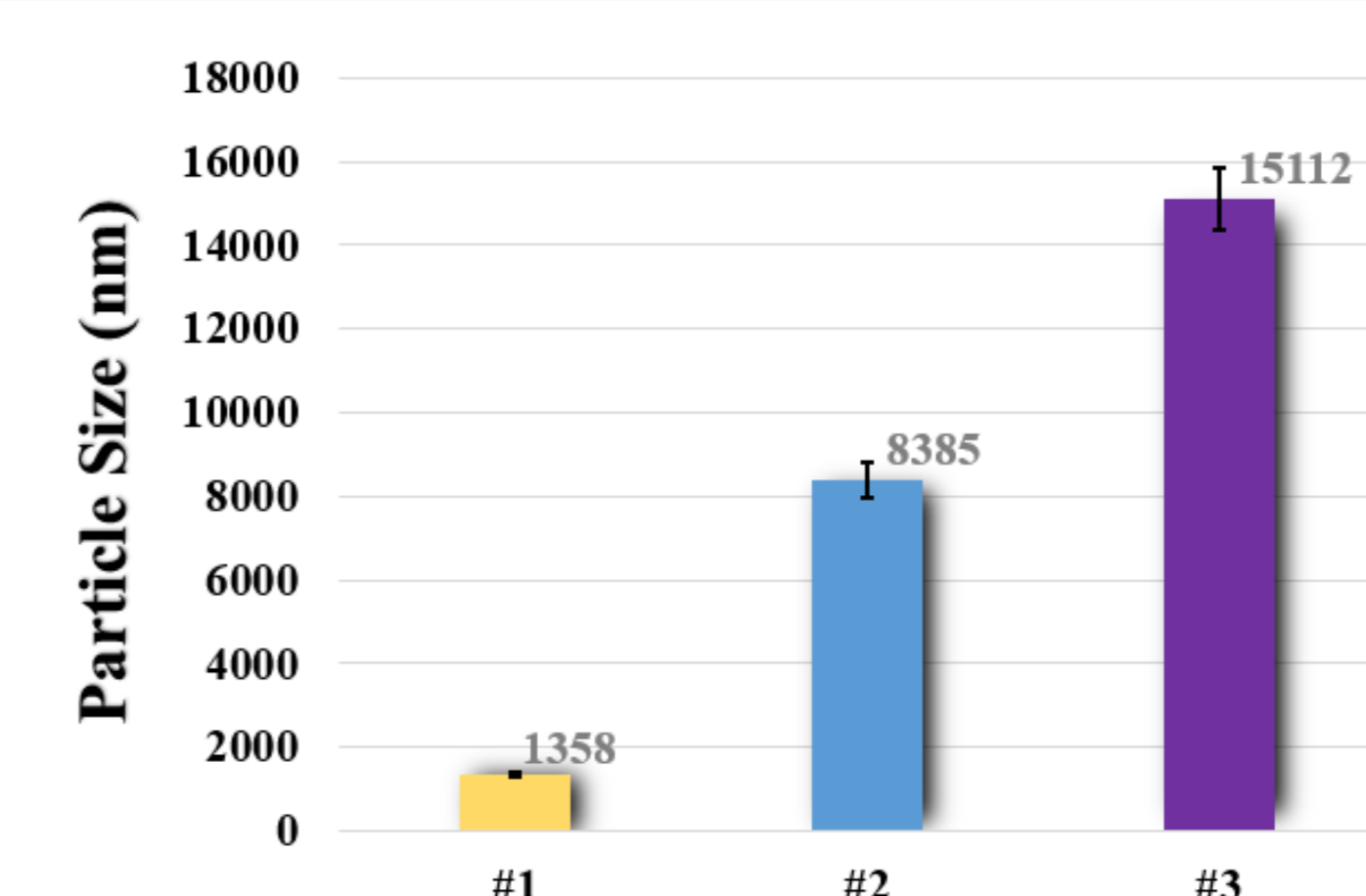
Scheme



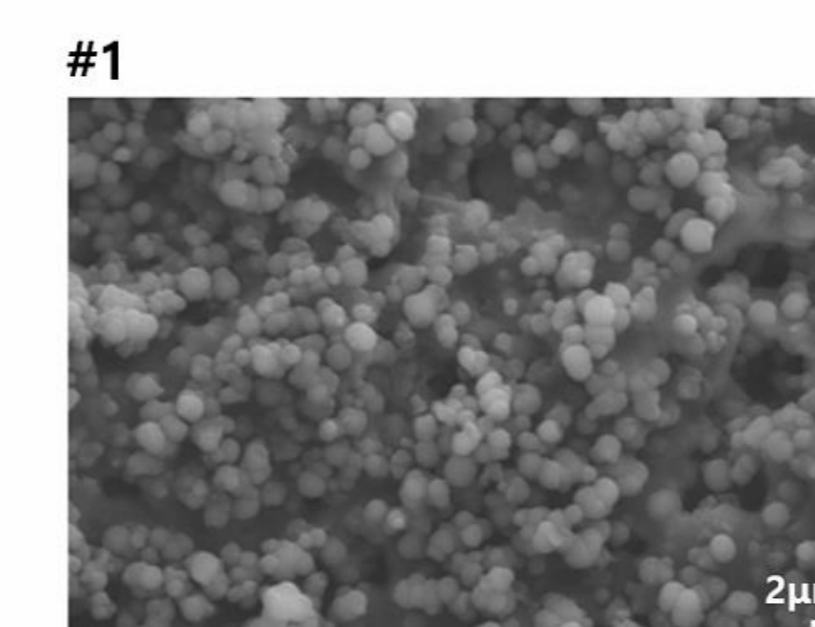
Results

Analysis of GPC & DLS(Particle Size)

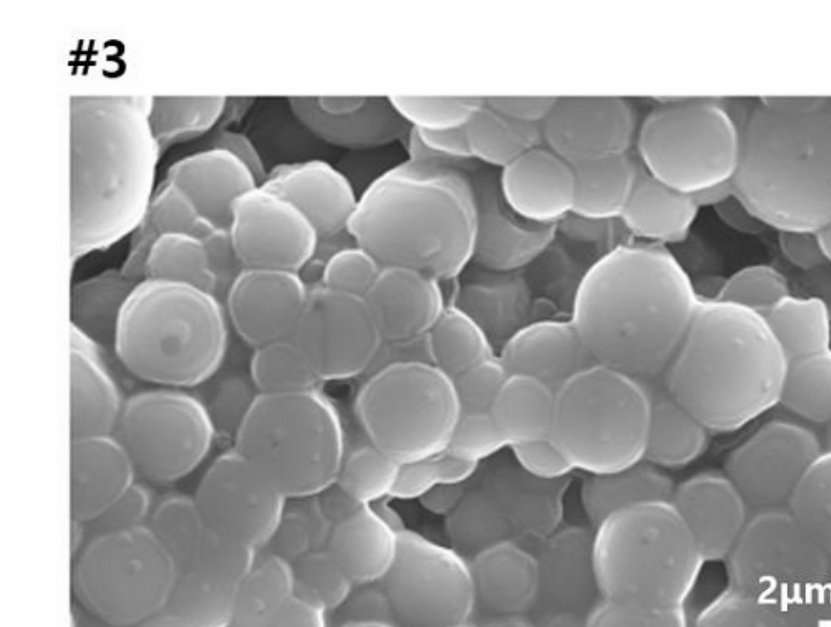
	M _n	M _w	PDI
#1	3840	8420	2.19
#2	6700	17670	2.64
#3	17100	48540	2.84



Morphology of LC Capsules : FE-SEM



diameter: 1.83±0.32 μm



diameter: 8.72±1.63 μm

Conclusion

- Waterborne polyurethanes (WPU) with LC were successfully synthesized to micro size.
- LC capsule size was controlled by molecular structure and weight design of PU prepolymer.
- The formed LC microcapsules were observed by FE-SEM.
- Microcapsule of WPUs with LC have potential to applications of smart window materials.

Acknowledgement

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