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The Membrane Formation Mechanism Study of CA+CQDs/NMP/H_2O System

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ABSTRACT

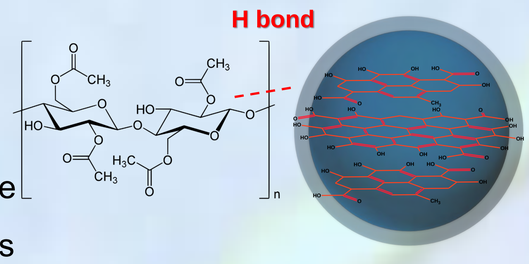
This study focused on the effects of carbon quantum dots (CQDs) addition on the membrane formation mechanism of cellulose acetate (CA) membrane. The thermodynamic stability was observed by the cloud point measurement and FTIR-microscopy, while the kinetic behavior was observed by optical microscope and light transmission. The dope demixing rate and water diffusion coefficient into the dope was increased accordingly as increasing the CQDs content. The addition of CQDs is effective in increasing demixing gap in the phase diagram. Moreover, the phase diagram of CA/NMP+CQDs/H_2O shows that the phase separation behavior of the top layer was mainly affected by the pseudo water layer, resulting in faster phase separation at top layer, while slower formation behavior at the deep layer effected by viscosity. Given the above observations, membrane formation of different CQDs addition was dominated by membrane thermodynamic at top layer and membrane kinetic at deep layer.

INTRODUCTION

➢ **Schematic illustration of interaction between CA and CQDs**

Cellulose acetate (CA)

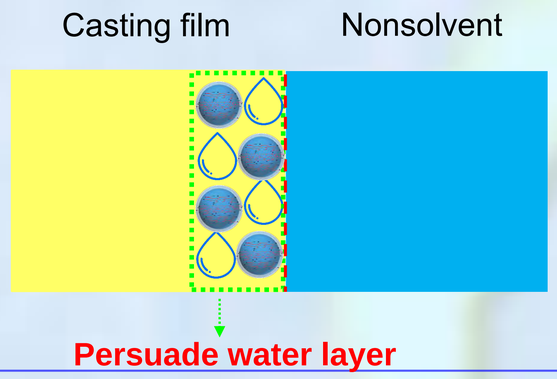
- Low cost
- Readily available material
- Hydrophilicity
- Good resistance to chlorine
- Easily dissolved in solvents



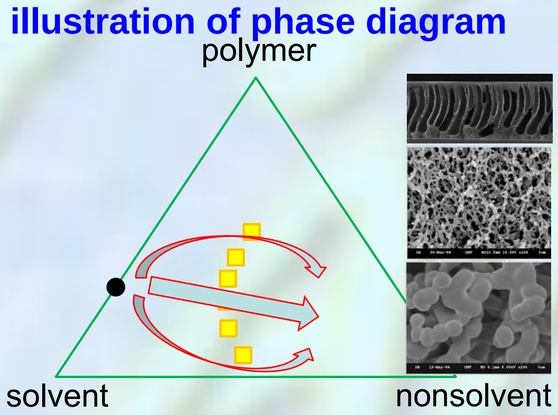
Quantum dots (QD)

- Zero dimension
- Water dispersibility
- Facile synthesis
- Inexpensive

➢ **The schematic illustration of persuade water**



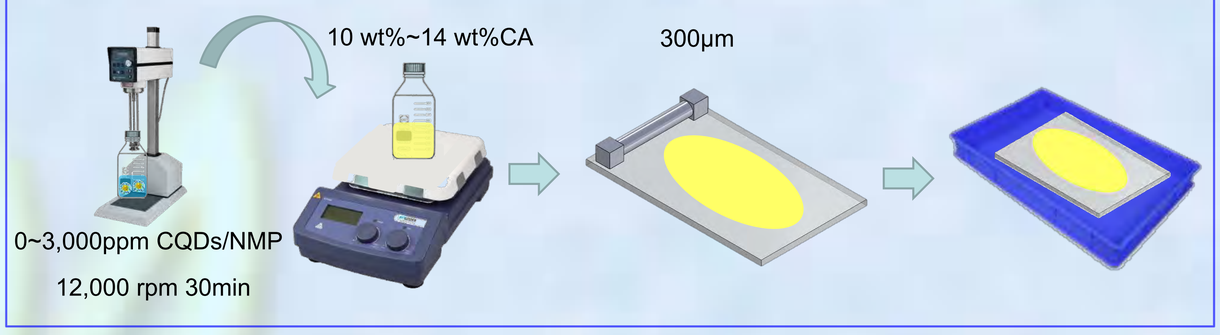
➢ **Membrane formation schematic illustration of phase diagram**



EXPERIMENT

➢ **Carbon quantum dot synthesis**

➢ **Membrane preparation**



RESULTS AND DISCUSSION

Table 1 Atomic composition of CQDs.

Elements	C (%)	O (%)	Na(%)
CQDs	58.63	34.97	6.4

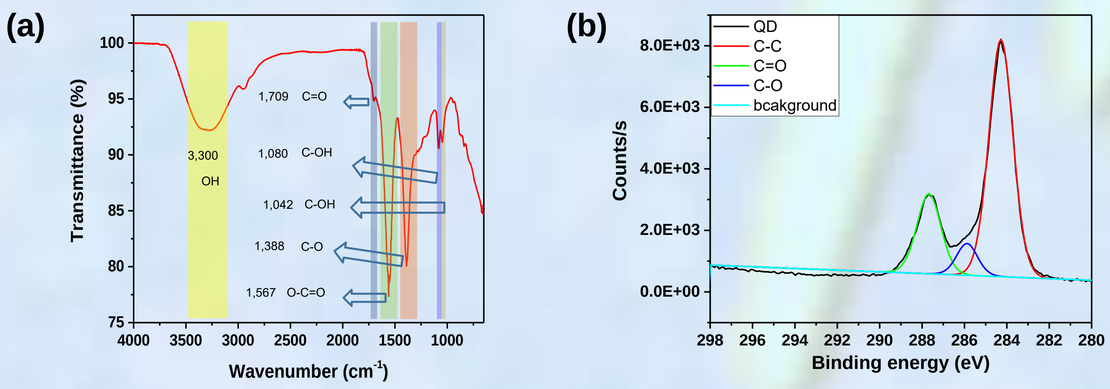


Figure 1 (a) ATR-FTIR spectra of CQDs; **(b)** C1s XPS narrow scan spectra.

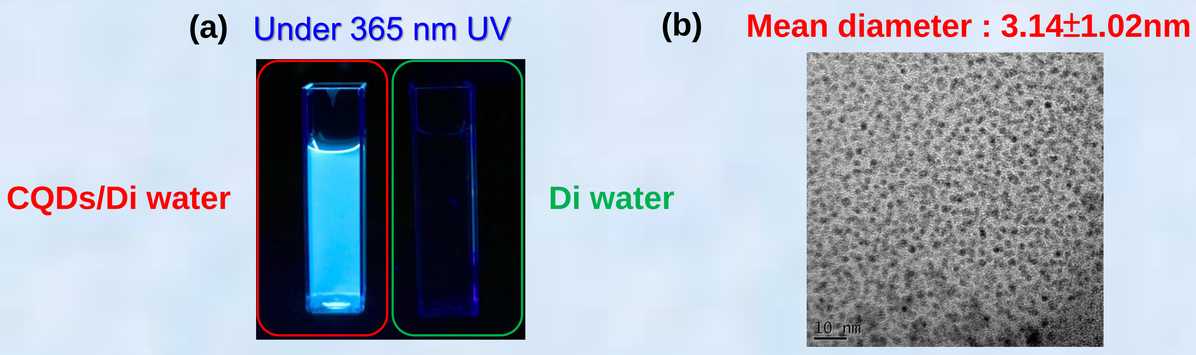


Figure 2 (a) Photo image of CQDs under 365 nm UV; **(b)** TEM image of CQDs.

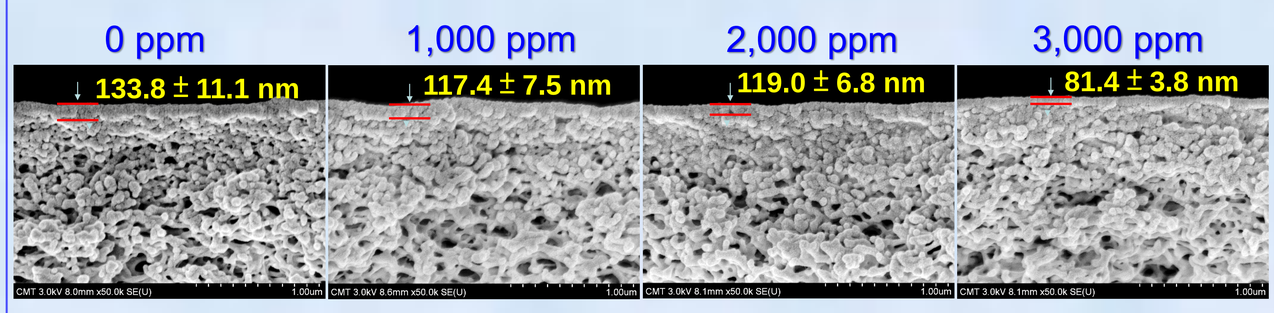


Figure 3 SEM cross-section images of CA and CA/CQDs membrane.

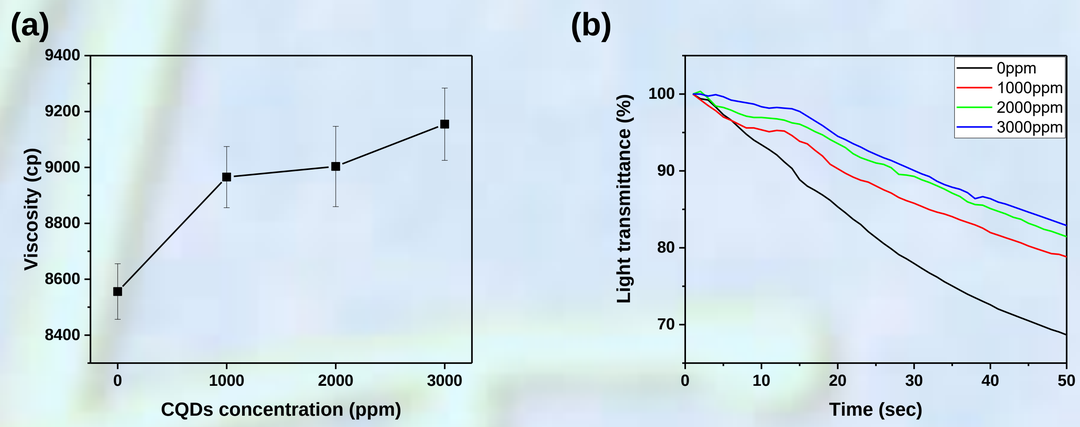


Figure 4 (a) viscosity measurement and **(b)** light transmission measurement of CA/NMP+CQDs solution.

Table 2 The diffusivity of water penetrate into CA/NMP+CQDs solution.

CQDs content (ppm)	Effective diffusivity ($x10^{-6}$ cm^2/s)
0	2.09±0.09
1,000	1.98±0.07
2,000	1.97±0.09
3,000	1.74±0.17

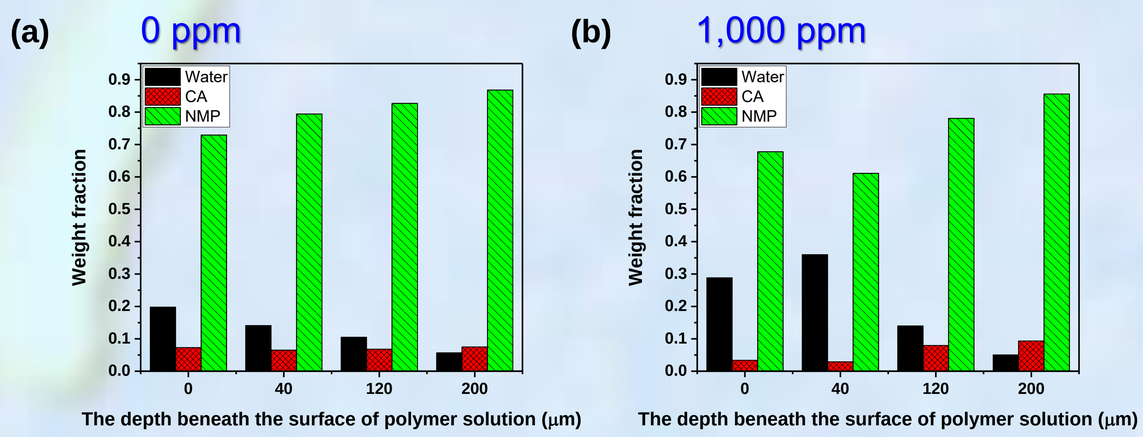


Figure 5 The weight fraction of individual composition of **(a)** 0 ppm **(b)** 1000 ppm.

CONCLUSIONS

1. **Nonsolvent effective diffusivity and phase separation rate decreases with increasing CQDs addition from optical microscopy and light transmission, respectively.**
2. **From FTIR microscopy, the phase separation behavior dominated by thermodynamic at top layer of membrane and dominated by kinetic at inner of membrane after addition of CQDs.**

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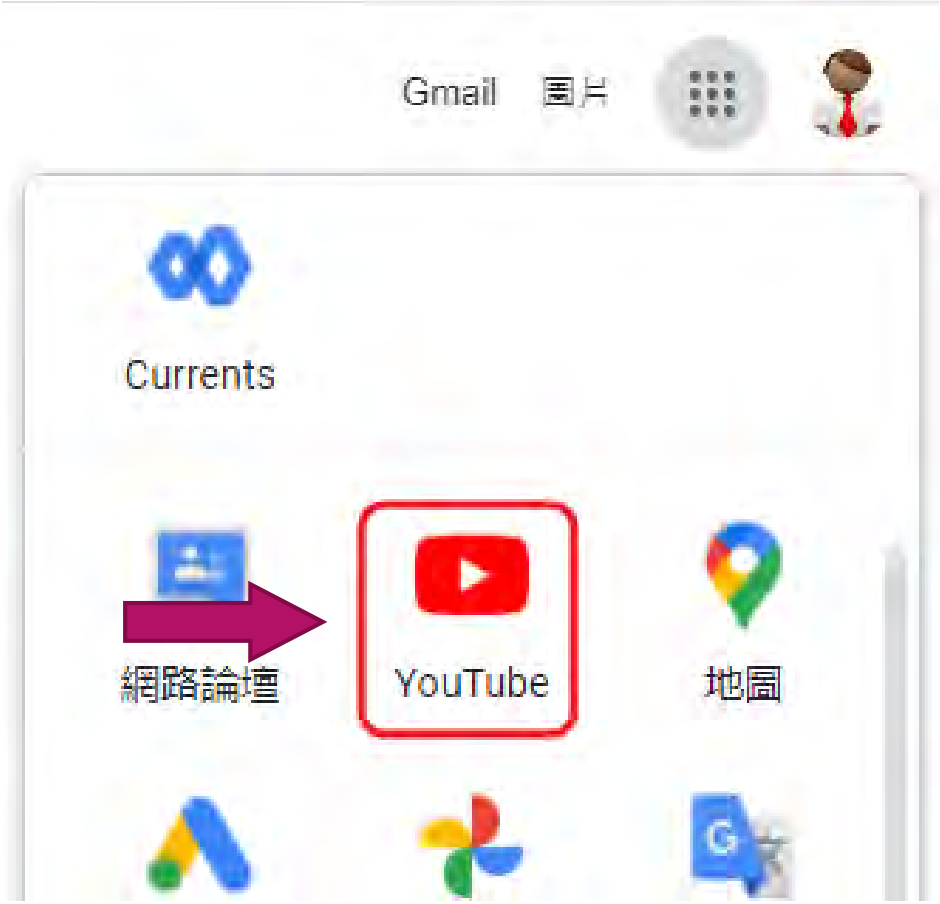

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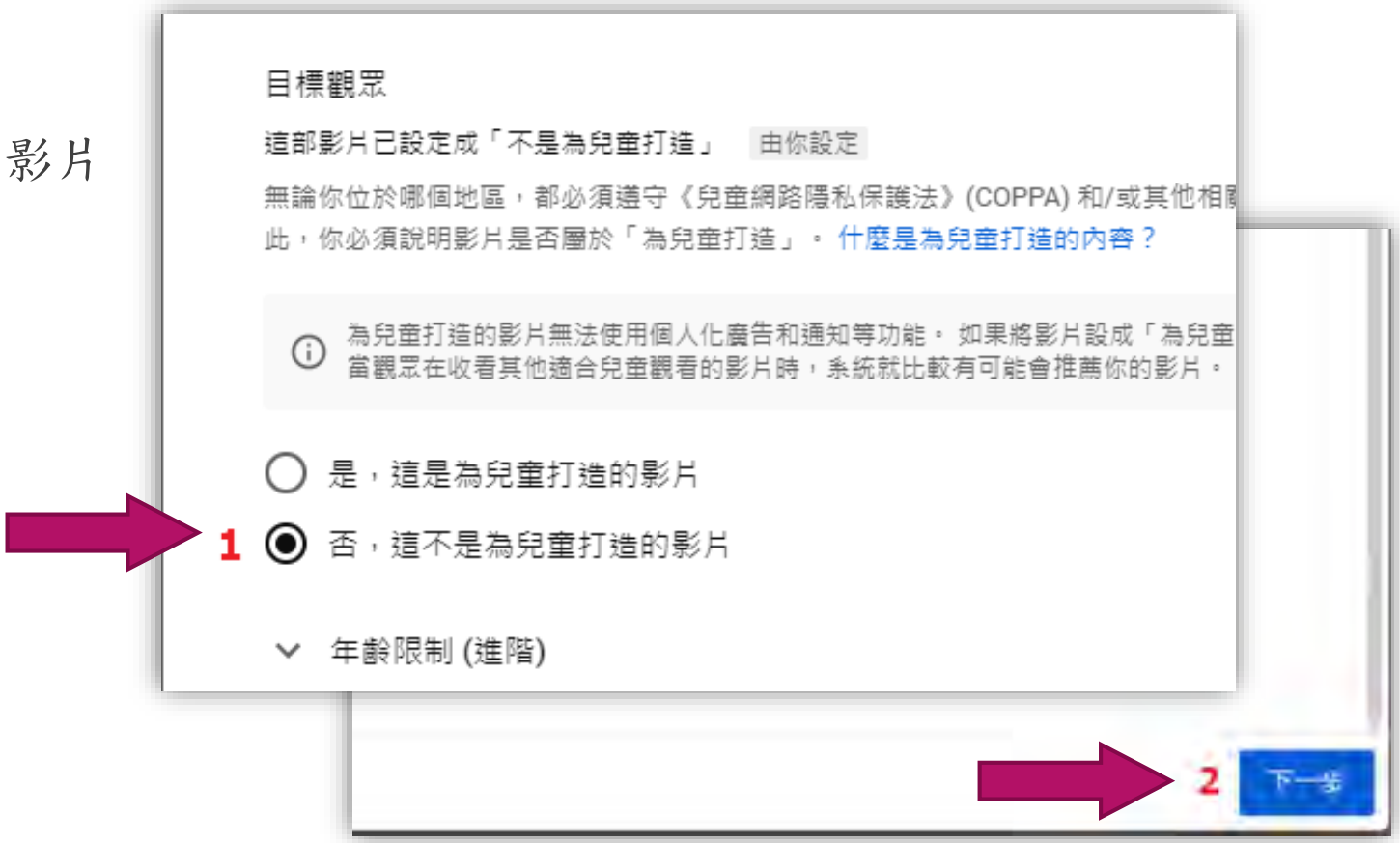

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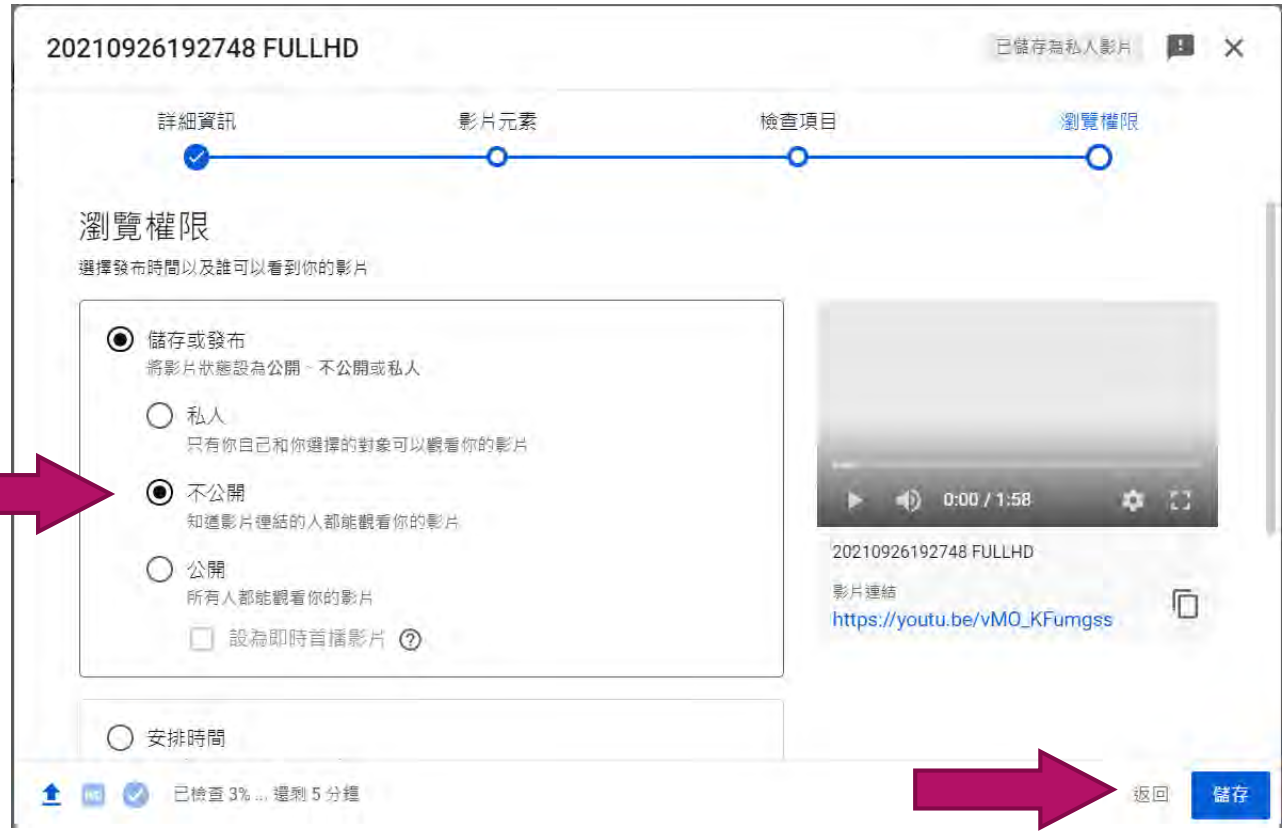

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