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Thermo-responsive smart glass based on an eco-friendly aqueous solution

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INTRODUCTION & AIM

Approximately 40% of global energy consumption occurs in buildings, with windows representing one of the least energy-efficient components. Smart glass technologies have demonstrated great potential for reducing energy use and enhancing indoor comfort.

However, limited attention has been given to the issues of material cost and recyclability. Consequently, the development of smart glass that is cost-effective, environmentally sustainable, and exhibits superior solar regulation performance is of critical importance.

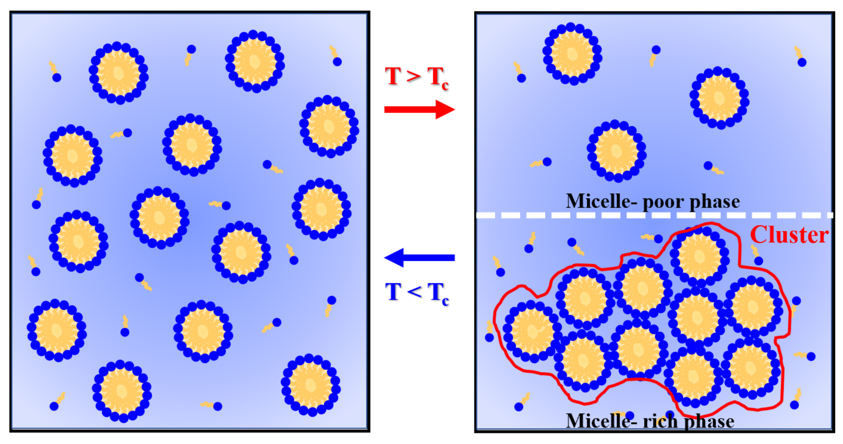
ECO FRIENDLY

METHOD & OPERATION PRINCIPLE

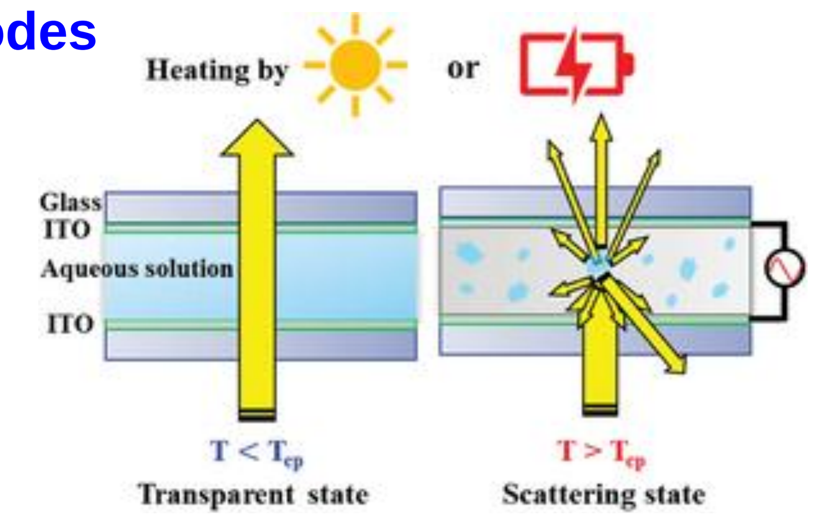
Materials

Triton CF-32:water = 1 wt%:99 wt%
Triton CF-32: non-ionic surfactant (Polyoxyethylene polyoxypropylene tert C12-13-alkyl amine)
T_c: cloud point temperature

Thermo-reversible phase separation

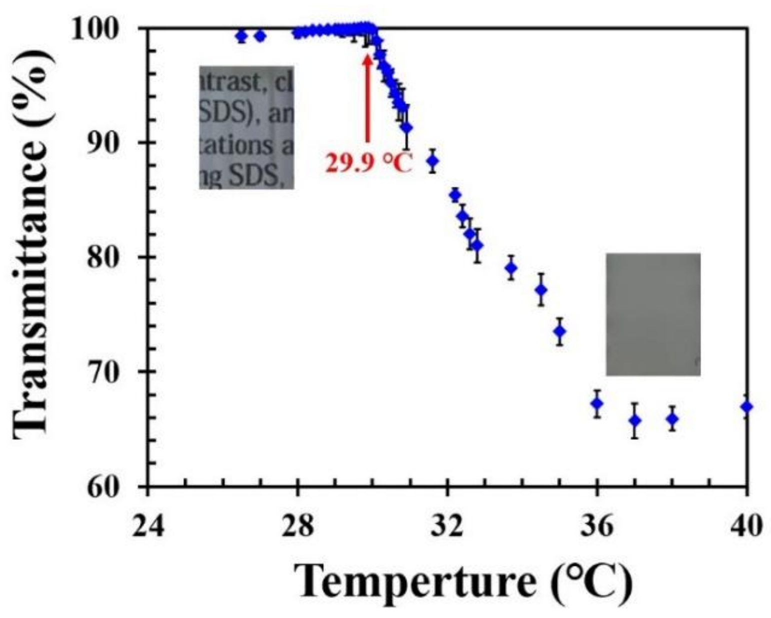


Temperature-dependent properties driven by passive and active modes

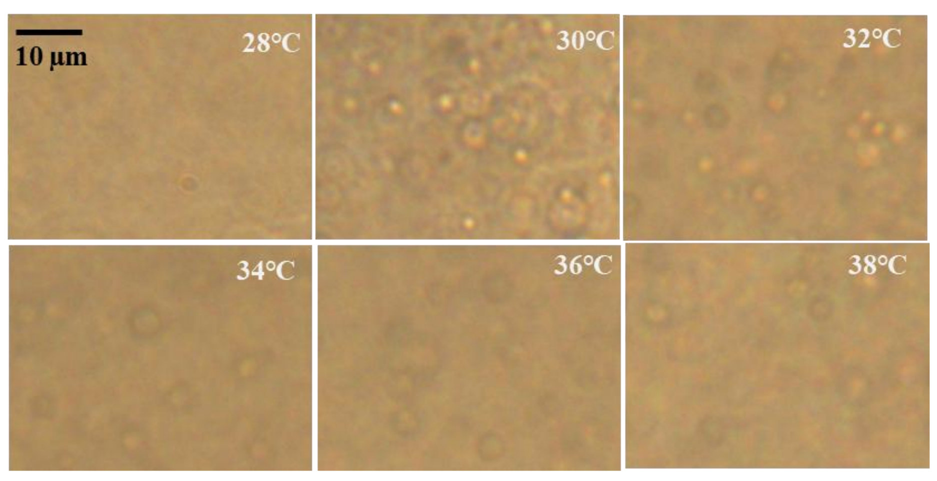


RESULTS & DISCUSSION

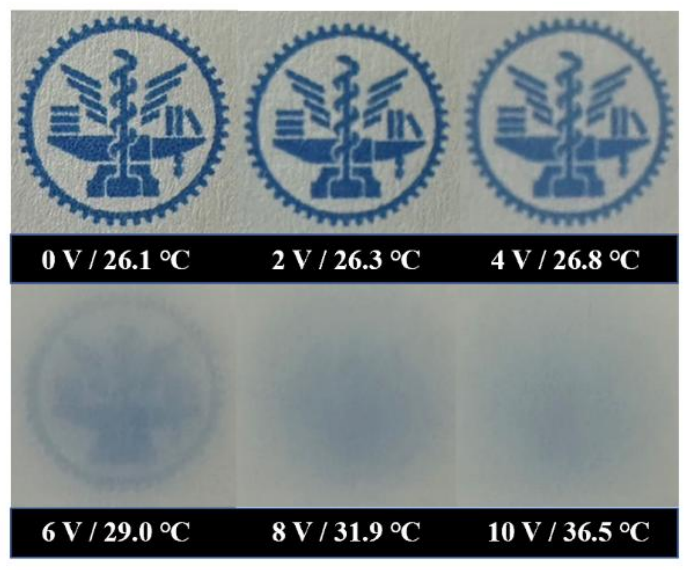
Cloud point temperature



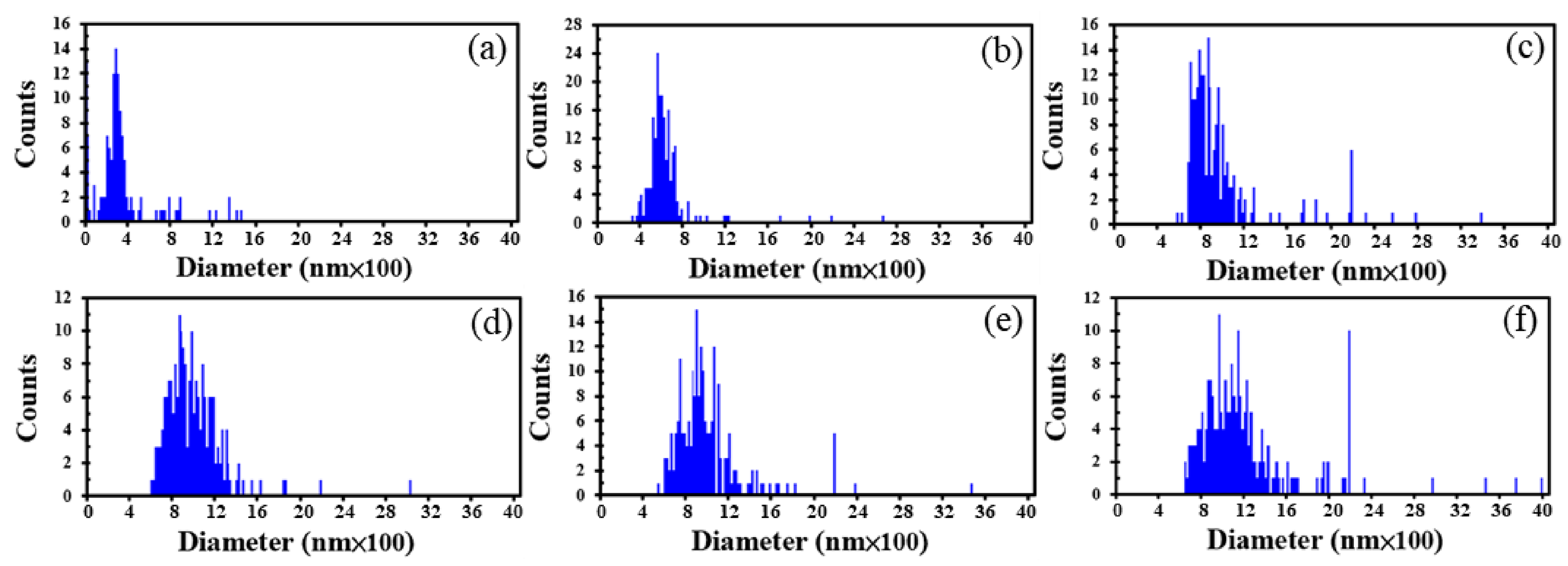
OM photos of the aqueous solution operated @ different temperatures



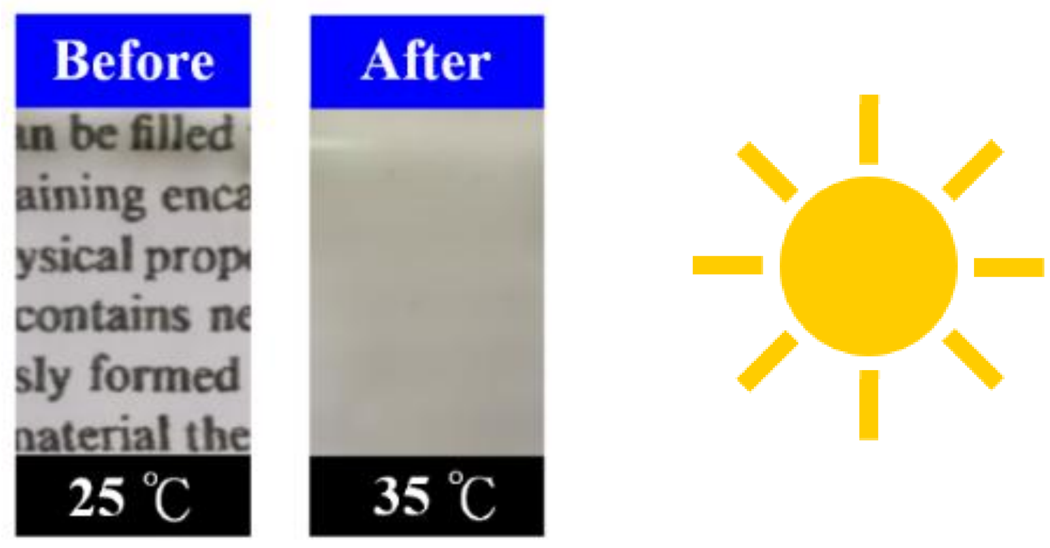
Active mode by external power



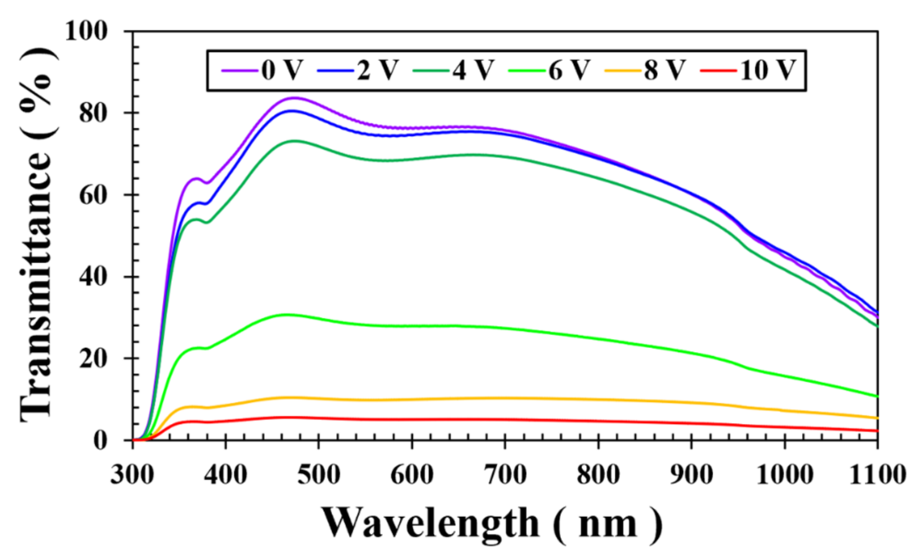
Dynamic light scattering: Average diameter vs. Temperature



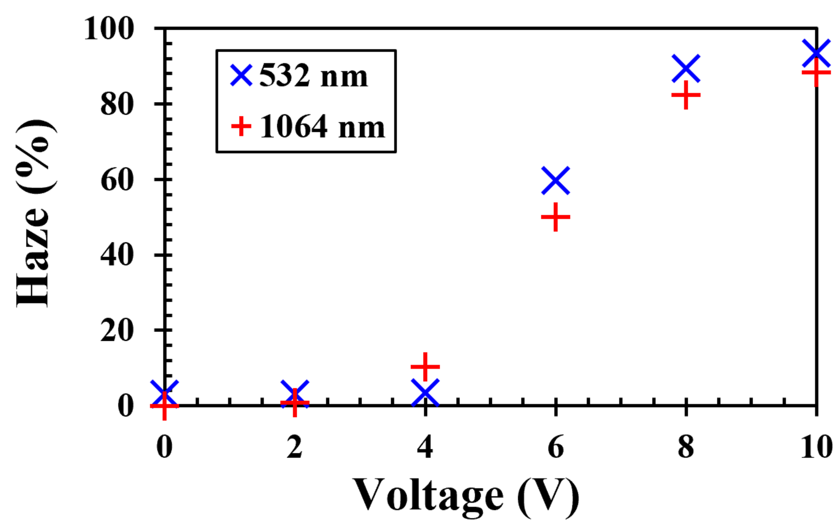
Passive mode by sun



Transmission spectra vs. Voltage



Haze vs. Voltage



Comparison of PDLC and this work for smart windows

Smart glass	PDLC	This work
Material	LC/polymer	Aqueous solution
Driving modes	Active	Active/Passive
Driving states	(on): Transparent (off): Scattering	(on): Scattering (off): Transparent
Haze	(on): 5% (off): 97%	(on): ~ 90% (off): ~ 3%
Response time	on: 10 ms off: 200 ms	on: 1 min off: 2.5 min
Energy consumption	5 - 10 W/m^2	25 - 640 W/m^2 (2 V ~ 10 V)
Eco-friendly	No	Yes

CONCLUSION

In summary, an eco-friendly, thermo-responsive smart glass was developed, capable of self-adjusting its transparency with temperature and being electrically tunable on demand. The glass exhibits ~77% luminous transmittance, ~90% haze, and ~64% solar modulation, providing an environmentally sustainable and energy-efficient solution.

REFERENCES

[1] M. Wu et al., ACS Appl. Mater. Interfaces 10, 39819 (2018).
[2] C. D. O. Rangel-Yagui et al., Braz. J. Chem. Eng. 21, 531 (2004).
[3] Y. Ke et al., ACS Appl. Mater. Interfaces. 8 33112-33120 (2016).