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# AIE active TPE mesogens with *p6mm* columnar and *Im3m* cubic mesophases and white light emission property

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**Abstract:** The discotic tetraphenylethylene (TPE) mesogens composing of a TPE core surrounded by four flexible 1,2,3-triazole dendritic paddles were synthesized efficiently *via* CuAAC click reaction. Interesting such TPE mesogens can self-assemble into not only the hexagonal columnar phase but also the rarely observed 3D micellar  $Im\bar{3}m$  cubic phase in their bulk states, as well as organogels with spherulitic or porous morphologies in organic solvents. AIE effects are observed in different aggregation states of such TPE mesogens. When such TPE mesogens are dispersed in nematic LC 5CB, dichroic ratio values up to 6.34 are obtained. Furthermore the emission colors of both pure TPE mesogens and the doped gel formed by doping TPE mesogen with DPP dye are tunable. Remarkably, **TPE/12+DPP/2C8** complex can exhibit stable white light emission (WLE) in gel state and poly(ethylene glycol) (PEG) film.

Keywords: tetraphenylethylene; self-assembly; AIE; organogels; white light emission

#### 1. Introduction

Luminogens with aggregation-induced emission (AIE) effects are current research interest because of their enhanced emission phenomena in solid states [1] and their great values as novel optical materials [2] and sensors [3]. AIE luminogens have been introduced into the skeletons of liquid crystals (LCs) and organogelators, the obtained AIE-active LCs [4] and organogels [5] with their unique combination of optophysical and ordered self-assembly features, have shown fascinating properties and promising application [6].

Tetraphenylethylene (TPE) derivatives are a novel sort of AIE luminogens with simple molecular structures [7] and easily functionalized character. A lot of functional TPE-based derivatives have been developed and found applications as fluorescent chemosensors [8-10] bioprobes [11-13], optoelectronic materials [14] and others [15]. A few of AIE active LCs have been constructed with TPE core surrounded by either flexible alkyl/alkoxy chains or mesogenic units [4b] *via* ether, ester [16] or 1,2,3-triazole linkages [4c], however only smectic [16c,17] or columnar mesophases [4c,16a,e] have been displayed by these reported TPE mesogens, thermotropic three dimentional (3D) micellar cubic phases have never been observed in these reported TPE mesogens.

Thermotropic 3D micellar cubic phases (Cub<sub>I</sub>) are resulted from the 3D self-assembly of spherical aggregates [18]. Surprisingly, the very complex  $P_{m\bar{3}n}$  lattice, constructed by eight spheroidic aggregates is strongly favored for such type of cubic phase as found in cone shaped compounds [19], and in few discotic molecules including phthalocyanine derivatives [20,21] and hydrogen-bonded G-quartet supramolecules [22], flat triphenylenes, and conic cycotriveratrylenes with peripheries of dendritic groups [23]. Only in few exceptional cases, such as in molecules with extended aromatic units [24-26] and strongly polar groups at the apex [27] an  $Im\bar{3}m$  lattice (body centered cubic BCC) was observed instead, and the occurrence of this  $Im\bar{3}m$  cubic phase cannot be expected.

On the other hand white-light emissive (WLE) materials have attracted considerable attention in information display, fluorescent sensors, and optical-recording systems [28]. They can be fabricated by merging components emitting three primary colors (red, green and blue) or two complementary colors (e.g. blue and yellow). Gelation of components emitting different colors can minimize the distance between the donor and acceptor molecules, and dedicate to the overlap of the emission spectra of the donor and the absorption spectra of the acceptor, which would be beneficial for the molecular energy transfer to obtain WLE materials with better performance [29]. Till now WLE gels containing the chromophore of organic molecules [30,31], organic metal coordination compounds [32] and rare earth metal ions [33] have been reported. Their great potentials in the areas including optical sensing, bio-imaging etc. would be expected [32c,34]. TPE active gels with blue, red and green emissions displayed morphologies with entangled bundles of fibrous aggregates [35], fibrous helical nanostructures [36], and a porous network structures [37] etc. have been reported. However, so far as we know, TPE organogel with WLE has not been reported. Recently, TPE based metal organic framework (MOF) [38] and metallacage [39] were used to fabricate white-light emissive diode (WLED), but TPE based metal-free organic white light emission materials has been rarely reported [40]. Based on these literature investigation, it should be very interesting to develop novel kinds of AIE-active LCs and organogels, as well as their application as optoelectronic devices. Therefore herein, we employed the click reaction to prepare the AIE-active discotic TPE mesogens consisting of a TPE core and four peripheral flexible triazole dendritic paddlers. The self assembly behavior, AIE and photophyical properties of such AIE-active discotic TPE mesogens were studied. The application of these TPE mesogens for WLE materials has also been investigated.

#### 2. Results and discussion

#### 2.1. Synthesis

All the target compounds were synthesized by using McMurry [41] and click reactions [42] as key steps (Scheme 1). The aromatic azides 2/n were obtained by nucleophilic substitution of appropriately substituted benzylchlorides 1/n with sodium azides. TPE phenol **3** was synthesized *via* the McMurry reaction from 4,4'-dihydroxybenzophenone [43]. The terminal alkyne **4** was obtained by etherification of TPE phenol **3** with propargyl bromide. Finally click reaction between terminal alkyne **4** and aromatic azides 2/n produced the target compounds **TPE**/*n*.



**Scheme 1.** Synthesis of compounds **TPE**/*n*: Reagents and conditions: (*i*)  $C_nH_{2n+1}Br$ , DMF,  $K_2CO_3$ , 90 °C, 12 h, 92%; (*ii*) LiAlH<sub>4</sub>, THF, 25 °C, 2 h, 87%; (*iii*) SOCl<sub>2</sub>, THF, 25 °C, 1 h, 95%; (*iv*) KI, NaN<sub>3</sub>, DMF, 45 °C, 12 h, 89%; (*v*) Zn, TiCl<sub>4</sub>, THF, -20 °C - 55 °C, 24 h, 32%; (*vi*) 3-Bromopropyne,  $K_2CO_3$ , CH<sub>3</sub>CN, 70 °C, 12 h, 93%; (*vii*) tert-Butanol, THF, H<sub>2</sub>O, sodium ascorbate, CuSO<sub>4</sub>·5H<sub>2</sub>O, 25 °C, 20 h, 75%-87%.

#### 2.2. Mesomorphic properties

The mesomorphic behaviors of these molecules were studied by polarizing optical microscopy (POM), differential scanning calorimetry (DSC) and X-ray diffraction (XRD). The phase transitions were summarized in Table 1. All the compounds were enantiotropic (thermodynamically stable) LCs. Columnar phases were displayed by all these compounds **TPE**/*n*. The lower homologues **TPE**/*n* with n = 8, 12 formed exclusively columnar phases in their whole mesomorphic temperature ranges, whereas additional optically isotropic phases with cubic lattices as higher temperature phases were found for higher homologues of **TPE**/*n* with n = 14, 16, 18 (Table 1). Under POM, **TPE**/*n* with n = 8, 12 showed the typical columnar textures with spherulitic domains. Observed with an additional  $\lambda$ -retarder plate, the columnar phases are optically negative (Fig. 1a and Fig. S1), indicating that the intramolecular  $\pi$ -conjugation path (namely the long axis of the rigid cores) is on average vertical to the columnar mesophases.

The wide-angle X-ray scattering (WAXS) patterns of all the columnar phases are diffuse and have their maximum at d = 0.45-0.52 nm (Fig. S3b, S4, S5b, S6, S7b, S8b, S9b, S10b), which confirm the liquid-crystalline nature of all the columnar phases. The small-angle X-ray scatting (SAXS) patterns of all the columnar phases showed three small-angle reflections with ratio of reciprocal spacing of  $1: 3^{1/2}: 2$ , suggesting (10), (11) and (20) planes of hexagonal lattice with p6mm symmetry (Fig. 1b, and Fig. S3a, S4a, S5a, S7a). The lattice parameters of the hexagonal columnar phases are 3.76 nm, 4.16 nm, 4.44 nm, 4.75 nm and 4.94 nm for compounds TPE/8, TPE/12, TPE/14, TPE/16, and TPE/18 respectively (Table 1, and Tables S1-S3, S5, S7, S9). By calculation, there is about one molecule in each unit cell for the columnar phases (Table 1 and Table S9) [44]. Therefore on average one molecule should form a disk which is surrounded by flexible alkyl chains. Piling up of the disks leadsto columns which further organize into p6mm phase. Due to the propeller-shape of the tetraphenylethene, two neighboring molecules within a column are presumably rotate by 45° with respect to each other in order to achieve optimal space filling of the central core (Fig. 1c). The suggested models are consistent with the reconstructed electron density map (Fig. S11a), as well as the molecular dynamics (MD) annealed model (Fig. S11b) [45,46]. The intermolecular  $\pi$ - $\pi$  interactions and microsegregation of the rigid aromatic core



from the surrounding alkyl chain tails, as well as intermolecular dipole-dipole interactions are the driving forces for the self-assembly of such hexagonal columnar phases.

**Fig. 1.** Col<sub>hex</sub>/*p6mm* phase of **TPE/12**: (a) Textures under POM cooling at T = 70 °C; (b) XRD patterns at T = 70 °C; (c) The model for Col<sub>hex</sub> phase; (d) XRD patterns of Cub<sub>1</sub>/*Im* $\overline{3}m$  at T = 80 °C, the insert is the model of  $Im\overline{3}m$  phase.

As mentioned above, the lower homologues of **TPE**/*n* with n = 8, 12 form exclusively columnar phases in the whole mesomorphic temperature ranges, whereas additional optically isotropic phases with cubic lattices were found in the higher temperature ranges for higher homologues of **TPE**/*n* with n = 14, 16, 18. The DSC data further confirmed the existence of two different LC phases (Fig. S2c-e). This thermal behavior was also examined by polarized optical microscopy (POM). Taking compound **TPE/14** as an example, on cooling from the isotropic liquid phase, optically isotropic phase (nonbirefringent) with high viscous was observed at 80 °C, which was typically found in the cubic mesophases (Fig. S1e and S1f). On further cooling to 45 °C, the sheet-like texture was observed instead, indicating another LC phase (Fig. S1c and S1d). Under all the situations the cubic phase occurred in the higher temperature range above the columnar phase (Table 1). Thus upon chain elongation or temperature increasing, a transition from columnar to a cubic phase was observed. Because the curvature of the aromatic/aliphatic interface increased with rising temperature or elongation of alkyl chain, the cubic phases reported here were anticipated to be micellar cubic phases (Cub<sub>1</sub>) [47]. In the small-angle region there were several sharp reflections with reciprocal spacing ratio of  $1 : 2^{1/2} : 3^{1/2} : 2$ , indexed as (110), (200), (211) and (220) of a body centered lattice (Fig. 1d), the most likely space group was  $Im\overline{3}m$  with lattice parameter  $a_{cub} =$ 4.44 nm, 4.75 nm and 4.94 nm for the cubic phase of compounds **TPE**/n (n = 14, 16, 18) respectively (Table 1 and Tables S4, S6, S8, S9).

Comp.	$T/^{\circ}C [\Delta H/kJ \text{ mol}^{-1}]$	<i>a</i> /nm ( <i>T</i> /°C)	μ
TPE/8	Cr <20 Col <sub>hex</sub> /p6mm 81.5 [3.1] Iso	$a_{\rm hex} = 3.76 \ (60)$	1.27
<b>TPE/12</b>	Cr <20 Col <sub>hex</sub> /p6mm 100.5 [3.0] Iso	$a_{\rm hex} = 4.16$ (70)	1.21
<b>TPE/14</b>	Cr 33.9 [72.7] Col <sub>hex</sub> /p6mm 62.1 [0.4] Cub <sub>I</sub> /	$a_{\rm hex} = 4.44 \ (50)$	1.27
	$Im\overline{3}m$ 93.9 [0.8] Iso	$a_{\rm cub} = 4.93$ (80)	23.3
<b>TPE/16</b>	Cr 41.9 [76.9] Col <sub>hex</sub> /p6mm 59.3 [1.1] Cub <sub>I</sub> /	$a_{\rm hex} = 4.75 \ (40)$	1.36
	$Im\overline{3}m$ 96.4 [0.4] Iso	$a_{\rm cub} = 5.24$ (70)	20.6
<b>TPE/18</b>	Cr 58.9 [76.9] Col <sub>hex</sub> /p6mm 75.9 [1.1] Cub <sub>I</sub> /	$a_{\rm hex} = 4.94~(55)$	1.33
	$Im\overline{3}m$ 115.6 [0.4] Iso	$a_{\rm cub} = 5.31 \ (100)$	19.6

#### Table 1

The phase transition temperatures, XRD data and other data of compounds TPE/n.<sup>[a]</sup>

<sup>[a]</sup> Transition temperatures and transition enthalpies were determined by DSC (5 K min<sup>-1</sup>) and confirmed by POM, peak temperatures of the 2<sub>nd</sub> heating scan were given; abbreviations: Cr = crystal, Col<sub>hex</sub>/*p6mm* = hexagonal columnar phase with *p6mm* symmetry, Cub<sub>I</sub>/*Im* $\overline{3}m$  = cubic phase with space group *Im* $\overline{3}m$ , Iso = isotropic liquid, *a* = lattice parameter;  $\mu$  = number of molecules in the columnar slice for Col<sub>hex</sub>/*p6mm* phase ( $\mu = (a^2/2)\sqrt{3}h(N_A/M)\rho$ , assuming density of  $\rho = 1$  g/cm<sup>3</sup> and *h* = the height of each stratum of the columns measured by WAXS) or number of molecules in each spheroidic aggregates on average for Cub<sub>I</sub>/*Im* $\overline{3}m$  phase ( $\mu = n_{cell}/2$ ).

By comparison, the isotropic temperature of the columnar phase of **TPE/12** is 30 °C lower than that of the literature reported TPE triazole derivative 2 [4c] (Fig. S12) with the same alkoxyl chain length but without flexible methylenene oxide linkages in the peripheral, which indicated that the flexibility of peripheral triazole dendritic paddles has great influence on the stability of the mesophase. In the discotic TPE mesogens reported here, the flexibility of peripheral triazole dendritic paddles allowed the adoption of different conformations, leading to the denser packing of the TPE core units and favoring a much stronger interface curvature, thus leading to the formation of more stable columnar phase for compounds (**TPE/n**, n = 8, 12, 14, 16, 18) and micellar cubic phases for longer chain compounds (**TPE/n**, n = 14, 16, 18).

It should be noted that this is the first time that TPE derivatives display a micellar cubic phase, and most interesting the micellar cubic phase is with the rarely observed  $Im\overline{3}m$  (body centered) lattice.

#### 2.3. Gel properties

The gelation behavior of selected representative compounds **TPE/12** and **TPE/14** were tested in different solvents. The results were summarized in Table S10. The two compounds could gelate 1,4-dioxane and ethyl acetate (EA). The morphologies of the formed gels were studied by using a scanning electron microscope (SEM). The morphologies of the xerogels obtained from **TPE/12** and **TPE/14** in EA showed spherical structures with an average diameter of 5  $\mu$ m (Fig. 2a and Fig. S13a). The morphologies of xerogels obtained from **TPE/12** and **TPE/14** in 1,4-dioxane however showed a 3D porous structures with the diameters of 8  $\mu$ m and 1  $\mu$ m respectively (Fig. 2b and Fig. S13b). The different morphologies may be due to the different gelator-gelator/gelator-solvent interactions [48] and different polarities of the solvents.



Fig. 2. SEM images of the xerogels: (a) TPE/12 in ethyl acetate; (b) TPE/12 in 1,4-dioxane.

#### 2.4. Photophysical properties

#### 2.4.1. AIE in LC states

The AIE in LC states was tested with the representive compound **TPE/14**. Upon heating **TPE/14** from room temperature, PL spectra were recorded in its solid, LC and isotropic liquid states (Fig. 3). The fluorescence intensity is strongest in the solid state, slightly weaker in the LC states, and weakest in the isotropic liquid (Fig. 3a and 3b). Usually, the maximum wavelength changed little, but the emission intensity became weaker upon rising temperature. As shown in Fig. 3c, the emission color was bright blue for the Cr, then changed to be sky blue in the temperature range of  $\text{Col}_{hex}$  phase. Finally, the emission color changed to be bright green at the temperature range for the  $\text{Cub}_{I}$  phase. The light green emission persisted in the liquid phase but became dimmer upon rising temperature. The quenching of fluorescence by intermolecular  $\pi$ - $\pi$  stacking might be accompanied by non-radiative decay processes, being ascribed to an increased molecular mobility at a higher temperature and thus the increased possibility of the excited state to relax by internal energy conversion or transfer *via* collision [4c]. The emission color change of **TPE/14** observed during the heating process could be observed during cooling process too. This means that the change in emission color can be controlled simply by temperature. Such property could be applied to manufacture stimuli-responsive functional materials.



**Fig. 3.** (a) Emission spectra of compound **TPE/14** recorded during heating from solid to  $Col_{hex}$  *via*  $Cub_I$  to isotropic phase; (b) Plot of the emission intensity of the maximum wavelength *vs* the temperature; (c) Emission color change of **TPE/14** as a function of temperature under 365 nm UV light.

#### 2.4.2. AIE in gel states

Compounds **TPE**/*n* displayed gelation-induced fluorescence enhancement effect. As shown in Fig. S15a, the **TPE**/12 was nonfluorescent under 365 nm UV light irradiation when the gel was heated into the solution state. But strong blue emission light was observed in gel state when **TPE**/12 solution was cooled down.

The fluorescence intensity of **TPE/12** in the gel state and in the solution with the same concentration in EA was compared (Fig. S15b). The fluorescence intensity of the solution of **TPE/12** was rather weak. In contrast the fluorescence intensity of the corresponding gel of **TPE/12** increased by approximately 32.3 fold higher than that in solution. Such significant fluorescence increase from the gels was probably ascribed to the formation of more ordered assemblies in gel state. The organogels showed thermo-reversible property. For example after slowly heating **TPE/12** gel in EA to the higher temperature, the solution became clear. On cooling to room temperature, immobile gels was formed again (Fig. S16). The fluorescence intensity of the gel could be reversibly controlled with the gel solution transition by alternate cooling and heating process (Fig. S15). These switchable fluorescent organogels could have potentials as information storage devices [49-51].

#### 2.4.3. AIE in aggregate states

AIE properties of these compounds in aggregate states were studied in a mixture solution of THF/water. The fluorescence intensity of 10  $\mu$ m **TPE/14** in THF/water mixture with different water contents were recorded by PL spectra. As shown in Fig. S17, the fluorescence intensity was very weak and changed little as the water fraction of the THF/water mixture increased from 0% to 20%. After the water fraction reached >20%, the fluorescence intensity largely increased with the increase the water fraction up to 90%, which was approximately 9-fold higher than that in the pure THF. This indicated that the aggregates formed in the mixture. Dynamic light scattering measurements unveiled that nanoparticles were formed in the solvent mixture, whereas the diameter of the aggregates was determined to be 231 nm for **TPE/14** in THF/water mixture with  $f_w = 90\%$  (Fig. S18).

#### 2.5. Polarized emission spectra and the dichroic ratio

In recent years, light-emission liquid crystal displays (LE-LCDs) [17d,52] are considered as power efficient devices and are promising alternatives to conventional LCDs because they remove the polarizers and color filters. To realize such devices, strong fluorescent materials with a dichroic property are required. Combined with their liquid crystalline properties, TPE derivatives showed moderate fluorescent emission in the solid state ( $\Phi_F = 20.5\%$ ), it can be predicted that such AIE-active mesogens could be applied to fabricate LE-LCDs. In order to evaluate the potential application of **TPE/n** in LE-LCD, **TPE/18** as a representative compound was chosen to dissolve in commercial nematic liquid crystal 5CB at a concentration of 0.5% w/w for studying the dichroic ratio of polarized emission spectra in electric field-on (1 KHz, 8V) and electric

field-off states (Fig. S19, S20) [53]. Then the dichroic ratios were measured to be 6.34 in the electric field-off state (Fig. 4a) and about 1 in the electric field-on state (Fig. 4b). Based on this polarized fluorescence measurements, it can be predicted that the LC mixture of TPE derivatives and commercially available nematic LCs could be used to manufacture the LE-LCD.



**Fig. 4.** Polarized fluorescence spectra of light-emitting LC cell in (a) electric field-off (1 KHz, 8V) and (b) electric field-on states. The dichroic ratio ( $N_F$ ) was determined from the formula:  $N_F = F_{\perp}/F_{//}$ , where  $F_{\perp}$  and  $F_{//}$  are the rubbing direction of the LC cell perpendicular and parallel to the polarization direction of the detector, respectively.

#### 2.6. WLE in gel and PEG film

The pure TPE/12 gel exhibited cyan emission (400 nm - 600 nm). Its CIE coordinates were found to be (0.22, 0.32) (Fig. S21). Therefore it could generate white light by blending orange emission DPP derivative **DPP/2C8** (3,6-di(2-thienyl)-2,5-dihydropyrrolo[3,4-c]pyrrole-1,4-dione) [54]. The absorption spectrum of **DPP/2C8** was between 262-575 nm (Fig. S22). The partial overlap of spectrum was ideal for incorporating this DPP/2C8 into the gel of TPE for energy transfer application and also for tuning the emission color. The gels were obtained by adding DPP/2C8 into TPE/12 solution in EA (5 mg/mL). The dopped gels showed the changes in the emission spectra from blue, green, white to orange under UV light with varying DPP/2C8 mole ratio (Fig. 5a). After doping 20 µL of the DPP/2C8 with a concentration of 10<sup>-3</sup> (M) into TPE/12, the emission spectrum of the dopped gel covered the spectral range of 400-700 nm with three emission peaks centered at 471 nm, 567 nm, and 607 nm, respectively (Fig. 5a). The commission Internationale de L'eclairage (CIE) coordinates were found to be (0.32, 0.33) (Fig. S21), which was quite close to that of ideal white light emission (0.33, 0.33) [55]. The morphologies of the WLE gel were studied by SEM. The SEM image of the WLE xerogel showed tightly packed nanospheres with diameter of 3 µm (Fig. 5b) which was different from the morphology of xerogel of pure TPE/12 as shown in Fig. 2a.



**Fig. 5.** (a) Changes in the emission spectra of **TPE/12** gel in EA with varying **DPP/2C8** mole ratio (1 gel: pure **TPE/12**; 2 gel: **TPE/12** with 4 μL **DPP/2C8**; 3 gel: **TPE/12** with 20 μL **DPP/2C8**; 4 gel: **TPE/12** with 100 μL **DPP/2C8**; 5 gel: **TPE/12** with 500 μL **DPP/2C8**, inset: photographs showing luminescent colors upon irradiation with 365 nm light with different **DPP/2C8** concentrations, (b) SEM images of the xerogels 3.

Considering WLE materials employed in displaying device and lighting systems most of solid thin films [36,56], the solid-state optical properties of PEG film containing **TPE/12+DPP/2C8** gel was investigated. The PEG film containing **TPE/12+DPP/2C8** gel (a concentration of 5% w/w) was coated onto the surface of a commercial UV-LED flashlight ( $\lambda_{em} = 365$  nm) [40]. The coated film generated bright white light when the flashlight turned on (Fig. 6d, e, and Fig. S23). This film also showed excellent photostability and it could still emit bright white light one month later at ambient condition (Fig. S24).



**Fig. 6.** Photographs of UV-LED flashlight before (a) and after (c) being illuminated under nature light condition. Photographs of UV-LED flashlight coated by the PEG film containing **TPE/12+DPP/2C8** before (b) and after (d) being illuminated in darkness. (e) CIE chromaticity coordinates of the coated UV-LED flashlight: a (0.33, 0.30).

#### 3. Conclusion

Therefore discotic TPE based mesogens were synthesized efficiently *via* click reaction. By elongation of the alkyl tails, a transition from the hexagonal columnar phase to the rarely observed micellar body centered cubic phase with  $Im\bar{3}m$  lattice was observed. The  $Im\bar{3}m$  micellar cubic

phase showed by such TPE mesogens would be of highly importance because it is the first example of spherical thermotropic LC aggregates of TPE based derivatives. These AIE-active TPE mesogens were polarized emitting and had dichroic ratio values up to 6.34 when mixed with nematic LC 5CB. Remarkably the emission color of both pure TPE and the doped gel formed by doping TPE with DPP dye were tunable by rising temperature or changing the ratio of the DPP respectively. Most interesting white emission gels were firstly achieved by doping such TPEs with DPP dye. Furthermore the doped gel exhibited stable white light emission in the PEG film. In one word, our study should provide a prospective pathway for white light emission materials based on AIE active TPE mesogens.

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## Conflict of interest:

We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.



AIE active TPE mesogens can dispaly p6mm columnar and  $Im\overline{3}m$  cubic mesophases with white light emission property.

## Highlights

Designed AIE-active TPE mesogens could form hexagonal columnar phase and  $Im\overline{3}m$  micellar cubic phase.

White light emission organogel was obtained by doping such TPE mesogen with DPP dye. The WLE gel can generate stable white light emission in poly(ethylene glycol) film.