

ELECTRONIC SUPPLEMENTARY INFORMATION

Development of novel thioether compound for spontaneous chiral crystallization

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Fig. ESI-1

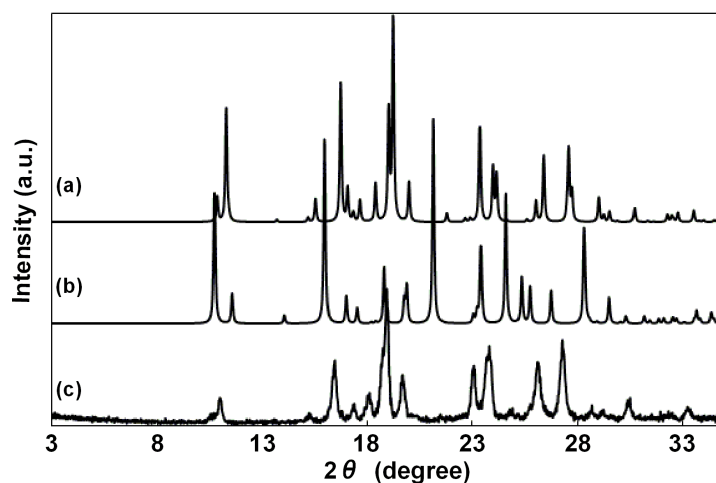


Fig. ESI-1 (a) Simulated X-ray powder pattern of crystal **II A** calculated from crystal structure data. (b) Simulated X-ray powder pattern of crystal **II B** calculated from crystal structure data. (c) X-ray powder diffraction pattern of crystals **II**.

Fig. ESI-2

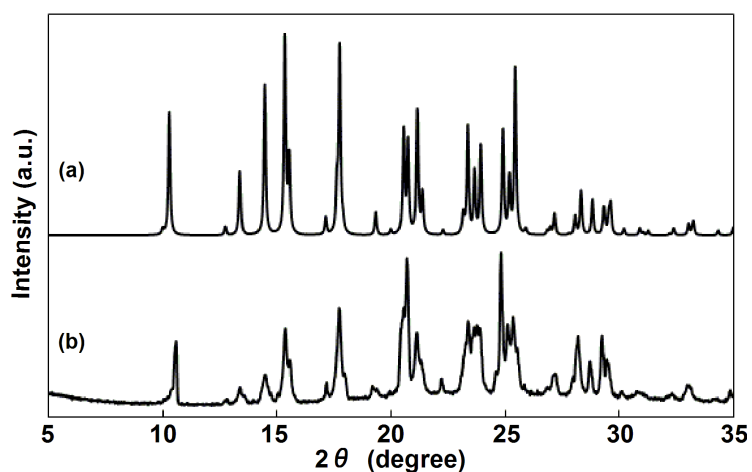


Fig. ESI-2 (a) Simulated X-ray powder pattern of crystal **IV** calculated from crystal structure data. (b) X-ray powder diffraction pattern of crystals **IV**.

1. Experimental

1.1. General methods

Crystallization solvents were purchased from Wako Pure Chemical Industry. These solvents were used directly as obtained commercially. ¹H-NMR spectra were recorded with a Varian Mercury M300 spectrometer in chloroform-*d* using tetramethylsilane as an internal standard (300 MHz). Infrared spectra (IR) spectra were recorded with a SHIMADZU FTIR-8400 by using KBr pellets. Mass spectra were recorded with a JEOL-JMS700T.

1.2. Synthesis of compound 2

Compound **2** was synthesized following the method in literature for related compounds with some modification.¹ 2,3-Epoxy-3-methyl-1-cyclohexanone (0.8 g, 6.3 mmol) and 2-naphthalenethiol (1.0 g, 6.2 mmol) were solved to *iso*-propanol (80 mL). After that, 15% potassium hydroxide (0.1 mL) solution was added to *iso*-propanol solution. The reaction mixture was stirred at room temperature for 3h. A diethylether (200 mL) was added to reaction mixture. The combined organic layers were washed with brine, dried over Mg₂SO₄, and evaporated under vacuum to give the crude thioether compound. Compound **2** was isolated as a solid by silica gel column chromatography (AcOEt/Hexane: 1/5) in 94% yield. ¹H-NMR (300 MHz, CDCl₃): δ 2.05-2.14 (m, 2H), 2.31 (s, 3H), 2.58-2.68 (m, 4H), 7.24-7.29 (m, 1H), 7.36-7.46 (m, 2H), 7.55 (d, *J* 1.8 Hz, 1H), 7.66-7.76 (m, 3H); IR (KBr): ν 1676, 1583, 848, 748 cm⁻¹; EIMS: *m/z* = 268.

1.3. Synthesis of compound 3

2,3-Epoxy-2-methyl-1,4-naphthoquinone (60 mg, 0.3 mmol) and 2-quinolinethiol (50 mg, 0.3 mmol) were solved to *iso*-propanol (20 mL). After that, 15% potassium hydroxide (0.03 mL) solution was added to *iso*-propanol solution. The reaction mixture was stirred at room temperature for 3h. A diethylether (100 mL) was added to reaction mixture. The combined organic layers were washed with brine, dried over Mg₂SO₄, and evaporated under vacuum to give the crude thioether compound. Compound **3** was isolated as a solid by silica gel column chromatography (AcOEt/Hexane: 1/1) in 62% yield. ¹H-NMR (300 MHz, CDCl₃): δ 2.46 (s, 3H), 7.37 (d, *J* 8.5 Hz, 1H), 7.44 (t, *J* 7.5 Hz, 1H), 7.58 (t, *J* 7.5 Hz, 1H),

7.68-7.79 (m, 4H), 8.02 (t, J 8.5 Hz, 2H), 8.18 (d, J 7.5 Hz, 1H); IR (KBr): ν 1658, 1589, 1280, 1137, 840, 748 cm^{-1} ; EIMS: m/z = 331.

1.4. Synthesis of compound 4

2,3-Epoxy-3-methyl-1-cyclohexanone (77 mg, 0.6 mmol) and 2-quinolinethiol (100 mg, 0.6 mmol) were solved to *iso*-propanol (150 mL). After that, 15% potassium hydroxide (0.05 mL) solution was added to *iso*-propanol solution. The reaction mixture was stirred at room temperature for 3h. A diethylether (250 mL) was added to reaction mixture. The combined organic layers were washed with brine, dried over Mg_2SO_4 , and evaporated under vacuum to give the crude thioether compound. Compound 4 was isolated as a solid by silica gel column chromatography (AcOEt/Hexane: 1/5) in 82% yield. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 2.11-2.20 (m, 2H), 2.28 (s, 3H), 2.66-2.72 (m, 4H), 7.17 (d, J 7.7 Hz, 1H), 7.40 (t, J 7.7 Hz, 1H), 7.60 (t, J 7.8 Hz, 1H), 7.69 (d, J 7.8 Hz, 1H), 7.81 (d, J 8.6 Hz, 1H), 7.90 (d, J 8.6 Hz, 1H); IR (KBr): ν 1676, 1593, 1421, 1087, 813, 756 cm^{-1} ; EIMS: m/z = 269.

1.5. X-ray crystallographic study of crystal

X-ray diffraction data for single crystals were collected using *BRUKER APEX*. The crystal structures were solved by the direct method² and refined by full-matrix least-squares using *SHELX97*.³ The diagrams were prepared using *PLATON*.⁴ Absorption corrections were performed using *SADABS*.⁵ Nonhydrogen atoms were refined with anisotropic displacement parameters, and hydrogen atoms were included in the models in their calculated positions in the riding model approximation. **Crystallographic data for IIA:** $\text{C}_{17}\text{H}_{16}\text{OS}$, $M = 268.36$, orthorhombic, space group $P2_12_12_1$, $a = 10.5932(8)$, $b = 11.4042(8)$, $c = 11.6692(9)$ Å, $V = 1409.72(18)$ Å³, $Z = 4$, $D_c = 1.264$ gcm^{-3} , $\mu(\text{Mo K}\alpha) = 0.218$ mm^{-1} , 12420 reflections measured, 3285 unique, final $R(F^2) = 0.0561$ using 2838 reflections with $I > 2.0\sigma(I)$, $R(\text{all data}) = 0.0636$, $T = 298(2)\text{K}$, *Flack param.* = -0.03(10), CCDC 749801. **Crystallographic data for IIB:** $\text{C}_{17}\text{H}_{16}\text{OS}$, $M = 268.36$, Orthorhombic, space group $P2_12_12_1$, $a = 9.7552(6)$, $b = 11.0921(7)$, $c = 12.3352(8)$ Å, $V = 1334.74(15)$ Å³, $Z = 4$, $D_c = 1.335$ gcm^{-3} , $\mu(\text{Mo K}\alpha) = 0.231$ mm^{-1} , 9720 reflections measured, 3305 unique, final $R(F^2) = 0.0325$ using 3125 reflections with $I > 2.0\sigma(I)$, $R(\text{all data}) = 0.0342$, $T = 125(2)$ K, *Flack param.* = 0.02(6), CCDC 749802. **Crystallographic data for III:** $\text{C}_{20}\text{H}_{14}\text{O}_2\text{SN}$, $M = 331.37$, Triclinic, space group $P-1$, $a = 7.7637(6)$, $b = 8.5895(6)$, $c = 12.7850(9)$ Å, $\alpha = 105.3860(10)$, $\beta = 98.5840(10)$, $\gamma = 105.8040(10)$ °, $V = 768.07(10)$ Å³, $Z = 2$, $D_c = 1.433$ gcm^{-3} , $\mu(\text{Mo K}\alpha) = 0.223$ mm^{-1} ,

6801 reflections measured, 3434 unique, final $R(F^2) = 0.0406$ using 3075 reflections with $I > 2.0\sigma(I)$, $R(\text{all data}) = 0.0452$, $T = 115(2)$ K. CCDC 749803. **Crystallographic data for IV:** $C_{16}H_{15}NOS$, $M = 269.35$, orthorhombic, space group $P2_12_12_1$, $a = 7.6159(5)$, $b = 10.3651(7)$, $c = 17.2948(12)$ Å, $V = 1365.24(16)$ Å³, $Z = 4$, $D_c = 1.310$ gcm⁻³, $\mu(\text{Mo K}\alpha) = 0.228$ mm⁻¹, 10197 reflections measured, 3379 unique, final $R(F^2) = 0.0303$ using 3143 reflections with $I > 2.0\sigma(I)$, $R(\text{all data}) = 0.0323$, $T = 120(2)$ K, *Flack param.* = $-0.07(5)$, CCDC 749804. These data can be obtained free of charge via www.ccdc.cam.ac.uk/conts/retrieving.html (or from the Cambridge Crystallographic Data Centre, 12, Union Road, Cambridge CB21EZ, UK; fax: (+44)1223-336-033; deposit@ccdc.cam.ac.uk).

References

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