# Smart Vaults: Thermally-Responsive Protein Nanocapsules

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## *SUPPORTING INFORMATION*

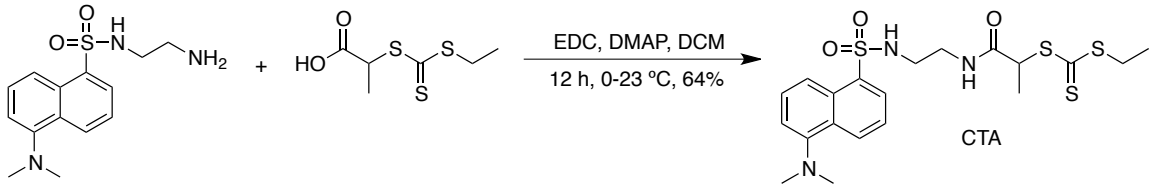
## Materials

Chemicals were purchased from Sigma-Aldrich, Fisher Scientific, and Acros. Methylene chloride was distilled after stirring with $CaH_2$ and stored under argon. 2-(((Ethylthio)carbonothioyl)thio)propanoic acid was synthesized according to a literature procedure.[1] *N*-(2-aminoethyl)-5-(dimethylamino)naphthalene-1-sulfonamide was synthesized according to a literature procedure.[2]

## Instrumental

NMR spectra were obtained on Bruker 500 MHz ARX, 500 MHz DRX, and 600 MHZ DRX spectrometers. Proton NMR spectra were acquired with a relaxation delay of 2 sec for small molecules. Mass spectra were obtained on a Waters LCT Premier with ACQUITY LC and autosampler. Infrared absorption spectra were recorded using a PerkinElmer FT-IR equipped with an ATR accessory DLS was performed on a Malvern Zetasizer Nano-S. TLC plates were pre-coated with Grace Davisil 60Å 40-63 μm and were developed in the indicated solvent systems. Grace Davisil 60Å 40-63 μm silica gel was used for column chromatography.

**Scheme S1.** Synthesis of dansyl CTA



**Synthesis of dansyl-trithiocarbonate CTA:** *N*-(2-aminoethyl)-5-(dimethylamino)naphthalene-1-sulfonamide (dansyl amine) (0.62 g, 2.95 mmol) was dissolved in dry methylene chloride (80 mL) in a flame dried flask with a stirring bar and cooled to 0 ºC. *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide (EDC) hydrochloride (0.46 g, 2.96 mmol) and 4-(dimethylamino)pyridine (DMAP) (0.04 g, 0.33 mmol) were added to the solution containing the dansyl amine and stirred for 1 h at 0 ºC. 2-(((Ethylthio)carbonothioyl)thio)propanoic acid (0.43, 1.47 mmol) was dissolved in 20 mL dry methylene chloride and added drop wise to the solution containing the dansyl amine, EDC, and DMAP. This solution was allowed to warm to room temperature and stirred for 12 h. Then the solution was washed 2 x 100 mL $H_2O$ and 2 x 100 mL saturated $NaHCO_3$ solution. The organic layer was dried with $MgSO_4$, filtered, and solvent was removed *in vacuo*. The crude product was purified via silica gel chromatography using a 2:1 hexanes: ethyl acetate eluent. The resulting CTA was obtained in 64% yield. $^1$H NMR (600 MHz, $CDCl_3$) δ: 8.54 (d, 8.53 Hz, 1H), 8.26 (d, 8.81 Hz, 1H), 8.21 (d, 5.87 Hz, 1H), 7.57 (t, 8.32 Hz, 1H), 7.51 (t, 7.83 Hz, 1H), 7.18 (d, 7.39 Hz, 1H), 6.65 (m, 1H), 5.51 (t, 6.11 Hz, 1H), 4.52 (q, 7.17 Hz, 1H), 4.11 (q, 7.17 Hz, 1H), 3.39-3.72 (m, 2H), 3.24-3.17 (m 1H), 3.06-2.96 (m, 2H), 2.88 (s, 6H), 1.45 (d, 6.99 Hz, 3H), 1.34 (t, 7.64 Hz, 3H). $^{13}$C NMR (500 MHz, $CDCl_3$) δ: 223.64, 171.40, 152.08, 134.48, 130.65, 129.93, 129.63, 129.51, 128.65, 123.22, 118.66, 115.37, 48.16, 45.44, 42.90, 39.69, 31.88, 16.32, 12.90. IR: 3282, 2931, 2868, 2831, 2788, 2254, 1654, 1612, 1587, 1573, 1527, 1452, 1406, 1372, 1354, 1312, 1264, 1231, 1201, 1160, 1141, 1076, 1028, 943, 907, 876, 814, 787, 682 $cm^{-1}$. HRMS (ESI) calcd for $C_{20}H_{27}N_3O_3S_4$ $[M + H]^+$ 486.1013, found 486.1003.

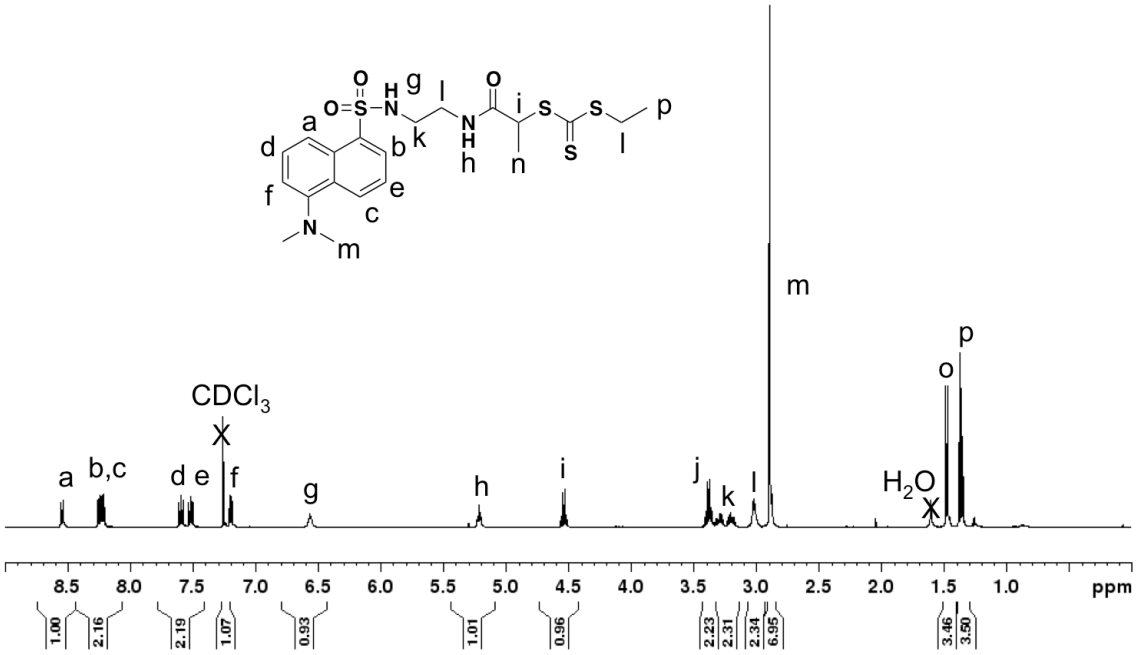



**Figure S1.** $^{1}$H NMR spectrum ($CDCl_3$) of dansyl CTA.

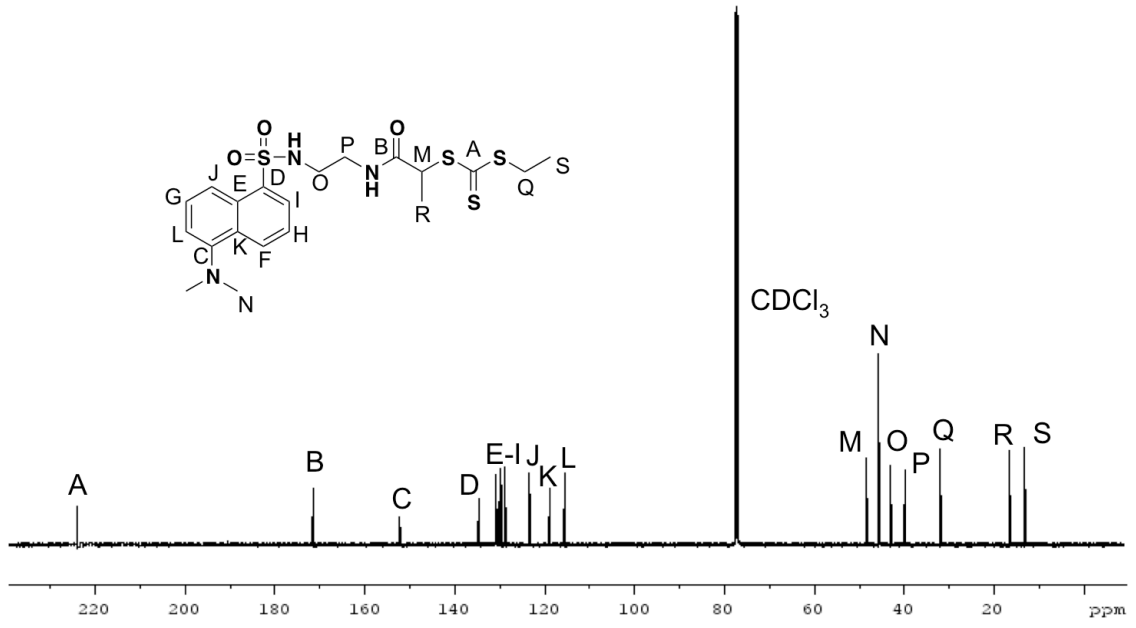



**Figure S2.** $^{13}$C NMR spectrum ($CDCl_3$) of dansyl CTA.

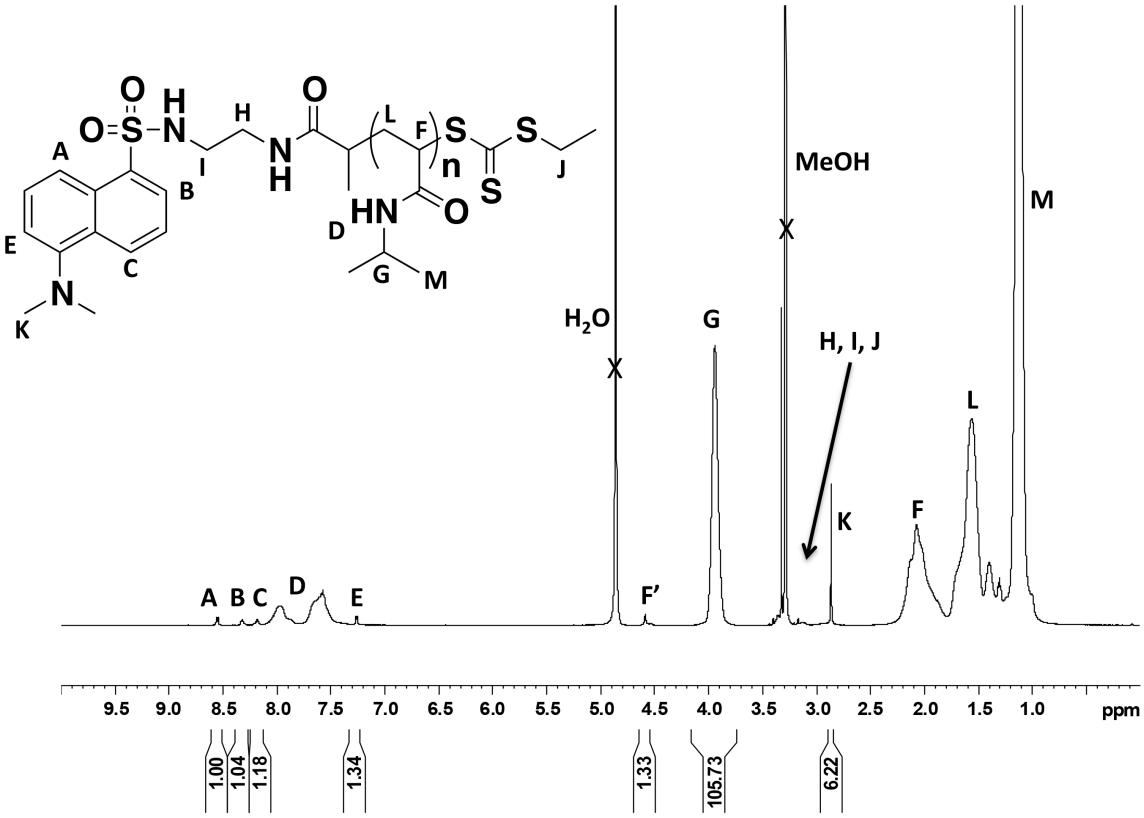



**Figure S3.** $^{1}$H NMR spectrum ($CD_3OD$) of **polymer 1**.

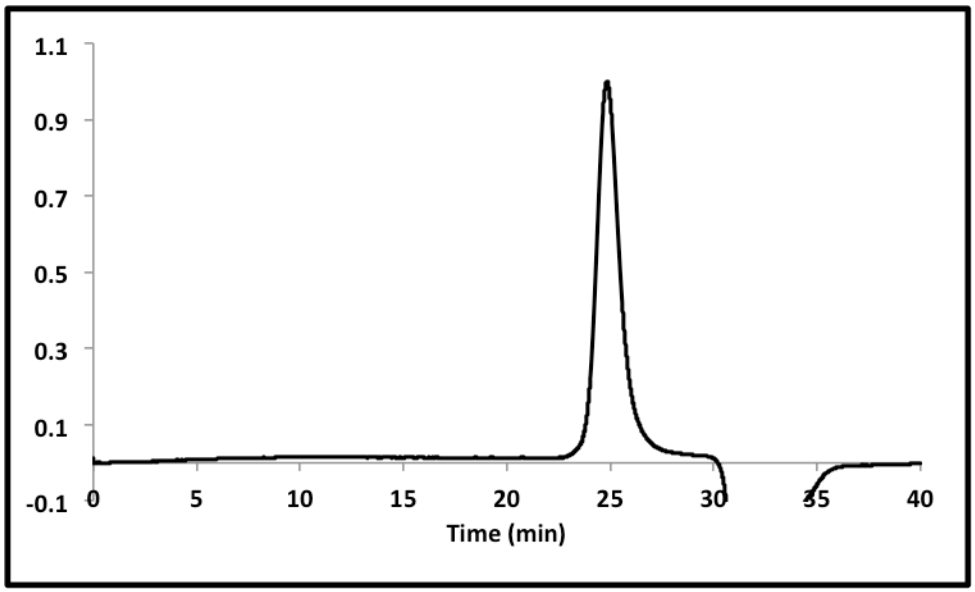


**Figure S4.** GPC trace of **polymer 1**.

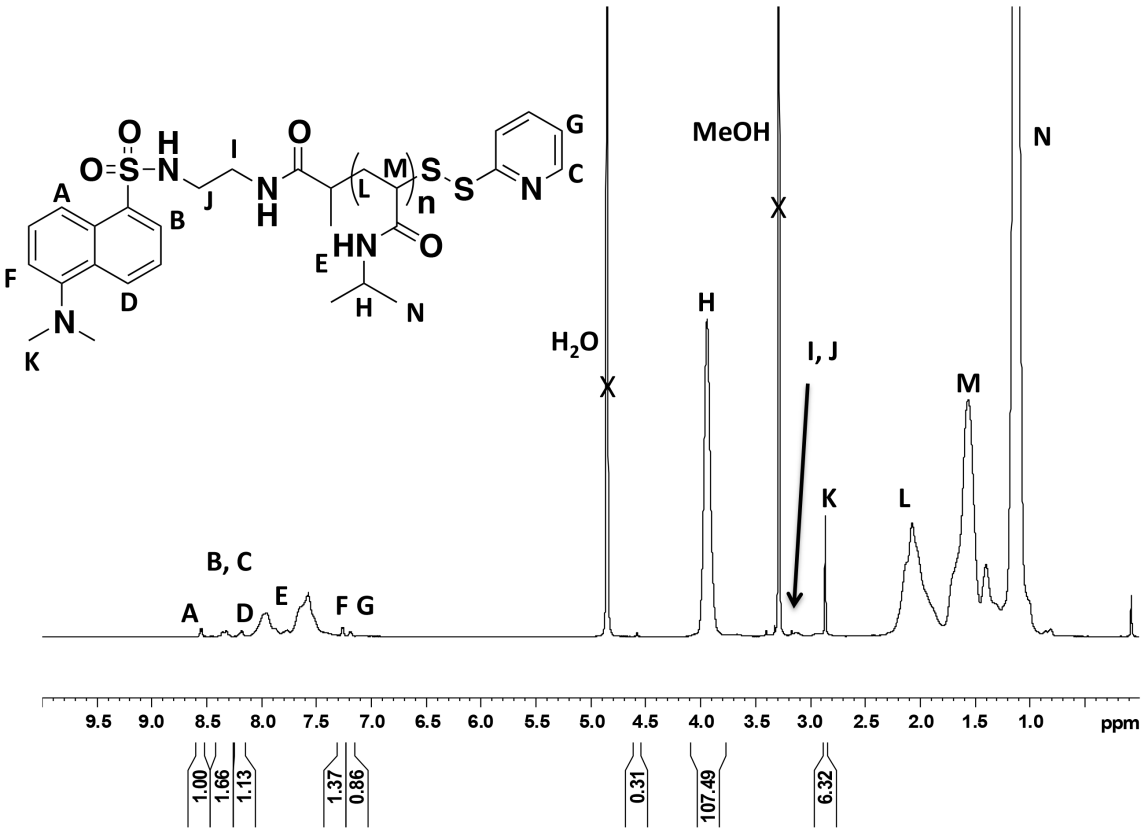



**Figure S5.** $^{1}H$ NMR spectrum ($CD_3OD$) of **polymer 2**.

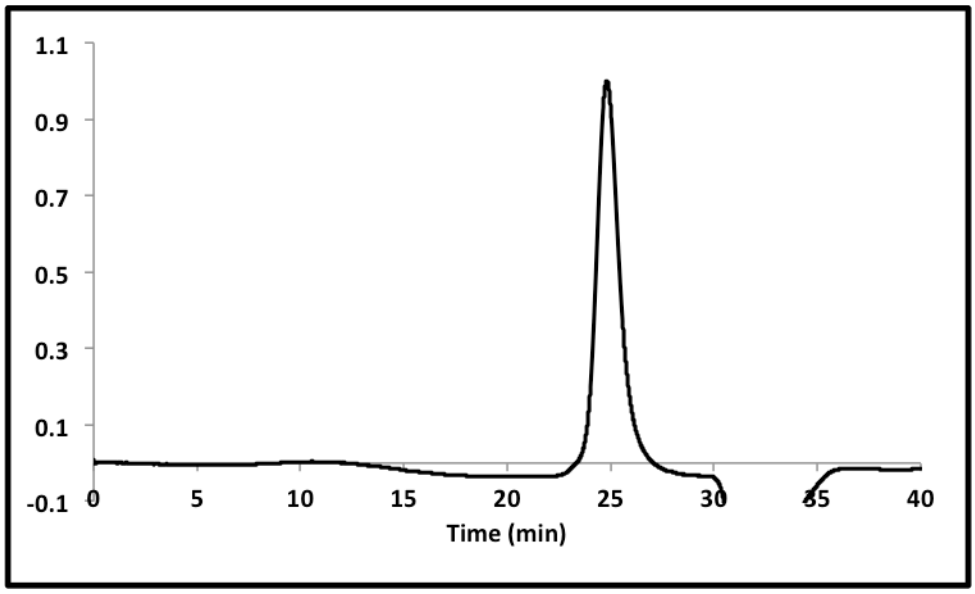



**Figure S6**. GPC trace of **polymer 2.**

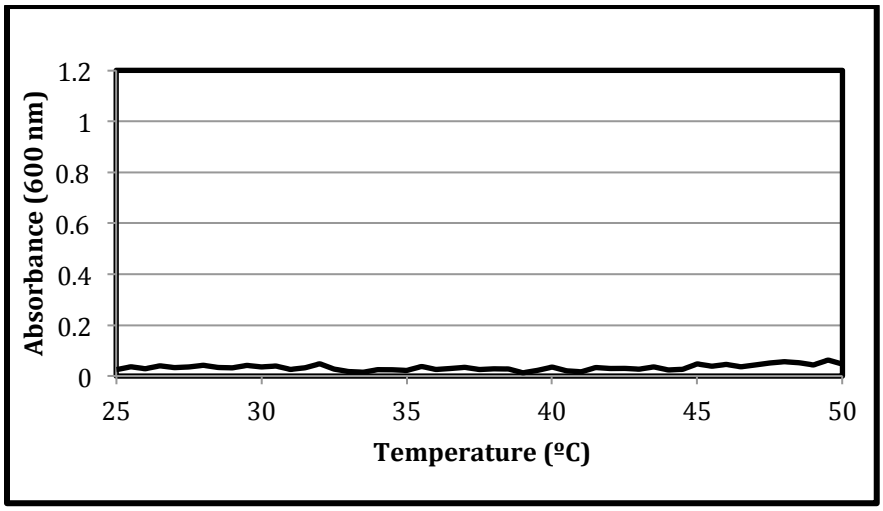



**Figure S7.** UV-Vis turbidity study of unmodified CP-MVP vaults. No LCST was observed.

## References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