# Supporting information for Novel multifunctional nano-hybrid polyhedral oligomeric silsesquioxane-based molecules with high cell permeability: Molecular design and application for diagnosis and treatment of tumors

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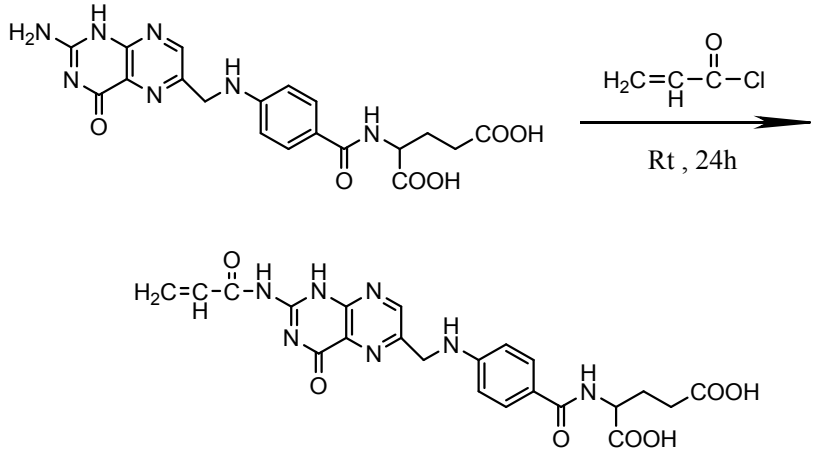
Targeting monomers ($R_1$) and fluorescent monomers ($R_2$) have been prepared according to the reported literature. [1,2]

1. Synthesis of acryl folic acid ($R_1$)

8.828 g (0.01 mol) of folic acid was dissolved in 50 mL of dried DMSO with vigorous stirring at 30℃ to form a uniform solution under dark, then 6.0 mL triethylamine as acid binding agent was injected. In addition, 2.0 mL (0.024 mol) of acryloyl chloride in 20 mL DMSO was dropwise added into the above dissolution for 30 min. The reaction solution maintained at 30 °C for 24 h. The reaction solution was extracted with acetone and then three times with ethanol. Yield: 4.42 g (50 %)

1HNMR (600 MHz, CDCl3, 298 K, δ/ppm): δ 8.64 (s, 1 H), 7.96 (s, 1 H), 7.63 (s, 1 H), 6.93 (s, 1 H), 6.66 (s, 1 H), 4.49 (s, 1 H), 4.28 (s, 1 H), 2.27 (s, 1 H), 2.01 (s, 1 H). FTIR (KBr): v=3000, 1635 cm−1 (NeC), 1243 cm−1 (CeO), 1618 cm−1 (C]C), 1591, 1580, 1496, 1454 cm−1 ($C_6H_6$).



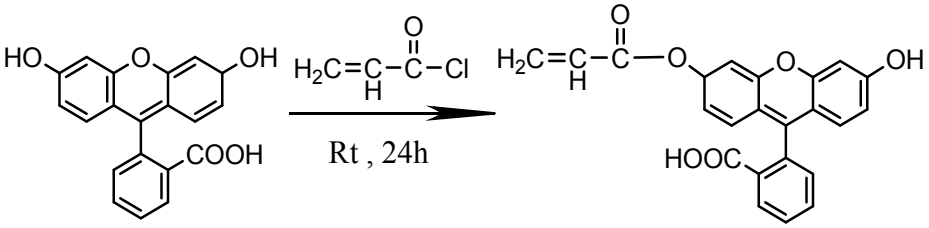

2. Synthesis of fluorescent monomers ($R_2$)

3.00 g ($9.0\times10^{-3}$ mol) fluorescein was dispersed in 20 mL dichloromethane. After dissolution, 3.0 mL triethylamine was added in the above solution. The mixture solution was kept in ice bath environment to obtain cool and uniformity mixture solution with magnetic stirring, then acryloyl chloride (0.90 mL, 0.011 mol) dissolved in 20 mL dichloromethane was slowly dropwise added for 30 min in ice baths. The mixture solution was kept at room temperature (25℃) for 24 h. After rotational evaporation, orange crystal raw product was obtained, which was further purified by

column chromatography machine with ethanol and chloroform (the volume ratio 1:30) as eluent. At last, allyl fluorescein with light yellow was obtained. Yield: 2.35 g (78.3 %)

1HNMR (600 MHz, CDCl3, 298 K, δ/ppm): δ 8.05 (d, 1 H), 7.68 (d, 1 H), 7.64 (d, 1 H), 7.29 (s, 1 H), 7.14 (s, 1 H), 6.82 (s, 1 H), 6.71 (s, 1 H), 6.65 (s, 1 H), 6.62 (s, 1 H), 6.55 (s, 1 H), 6.35 (s, 1 H), 6.10 (s, 1 H).

FTIR (KBr): v =1768 cm−1 (C=O), 1744 cm−1 (C=O), 1618 cm−1 (C=C), 1591, 1580, 1496, 1454 cm−1 (C6H6), 1243 cm−1 (CeO), 1111 cm−1 (CeOeC).



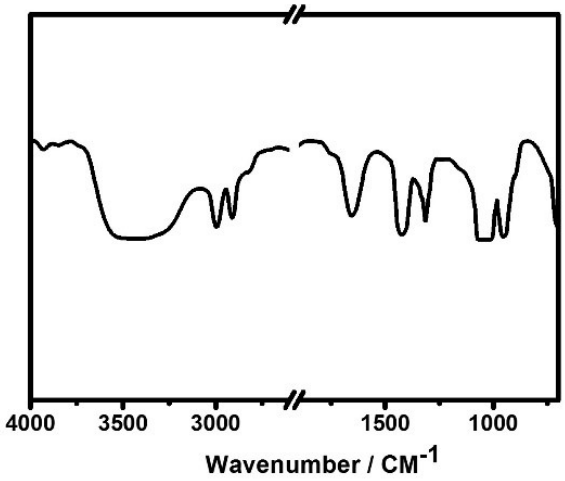



**Figure S1** The FTIR spectrum of $R_1$

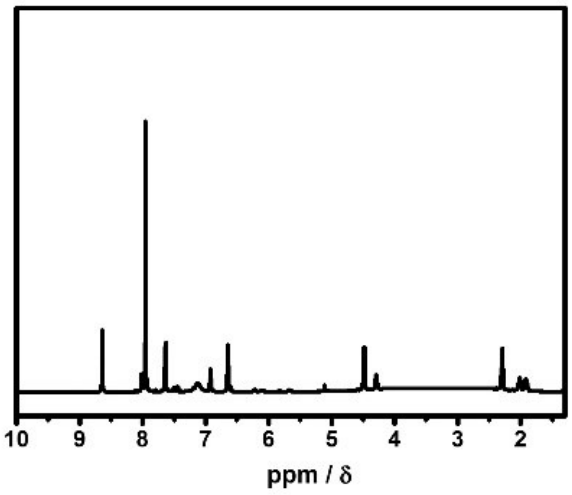



**Figure S2** The $^1H$ NMR of $R_1$

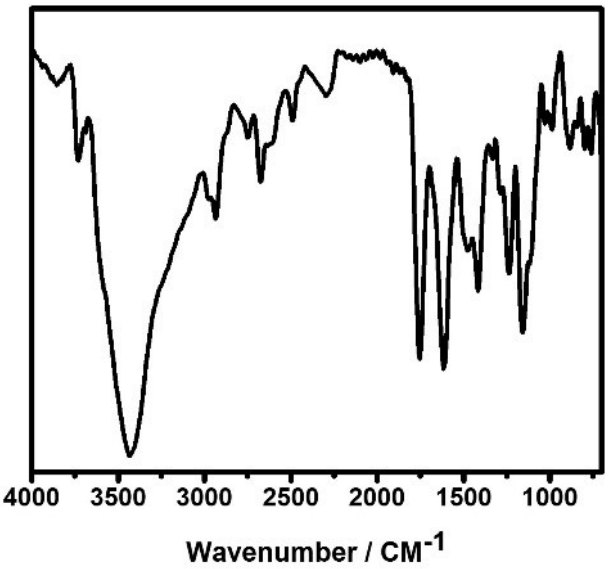



**Figure S3** The FTIR spectrum of $R_2$

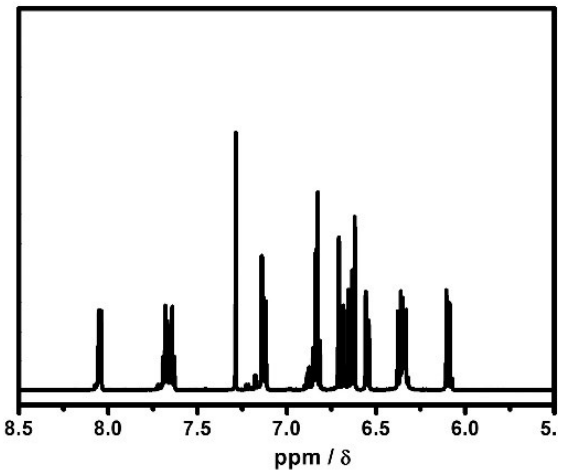



**Figure S4** The $^{1}H$ NMR spectrum of $R_2$

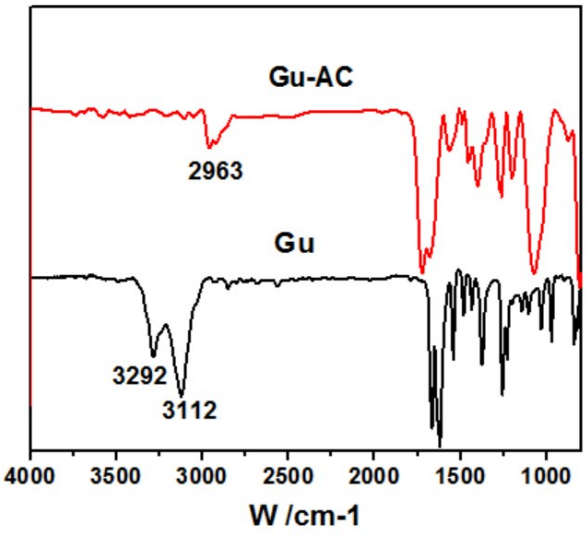



**Figure S5** The FTIR spectrum of $R_4$

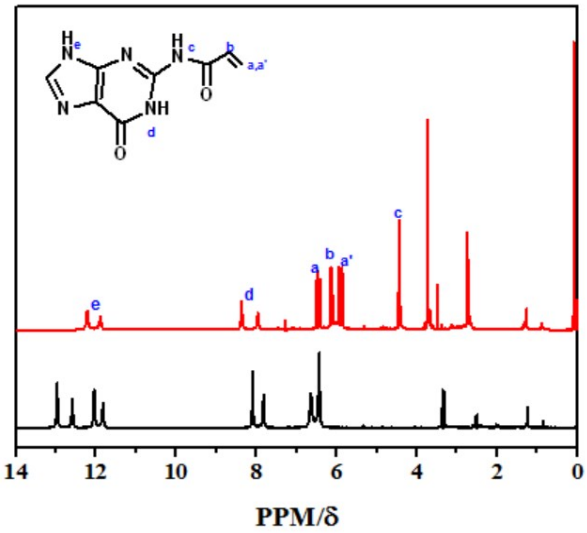



**Figure S6** The $^{1}H$ NMR of $R_4$

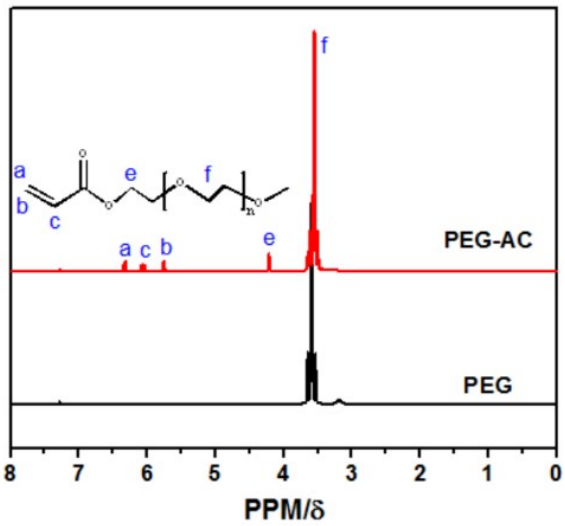



**Figure S7** The $^{1}H$ NMR of PEG-Ac

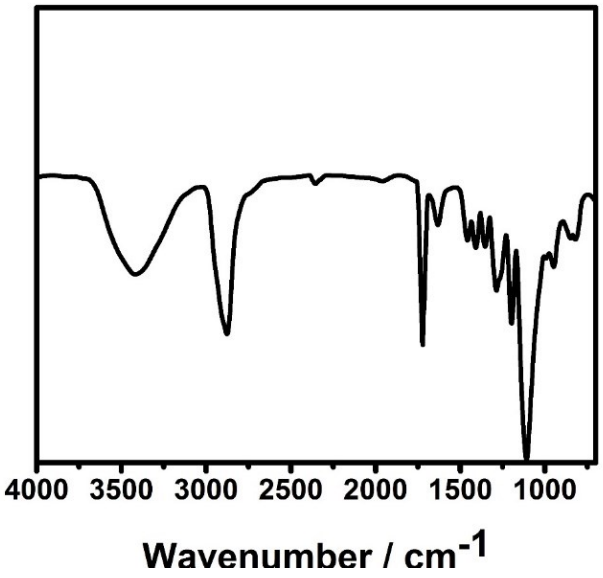



**Figure S8** The FTIR spectrum of PEG-Ac

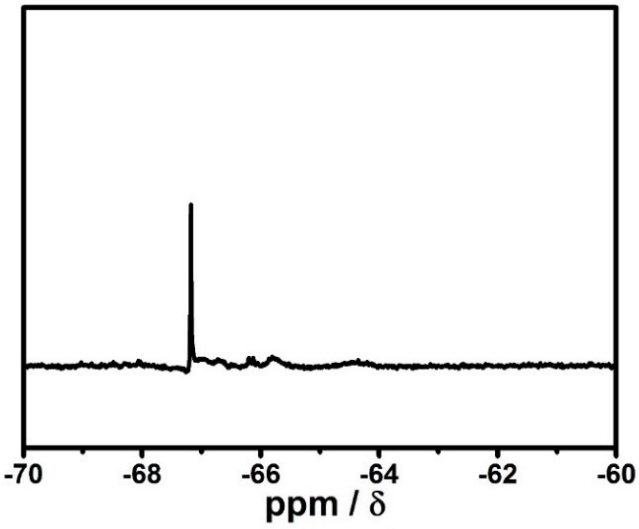



**Figure S9** $^{29}Si$ NMR of eight mercapto POSS

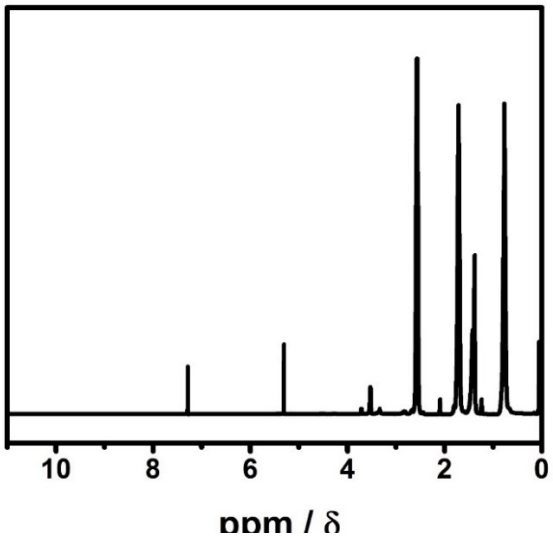



**Figure S10** The $^{1}H$ NMR of POSS

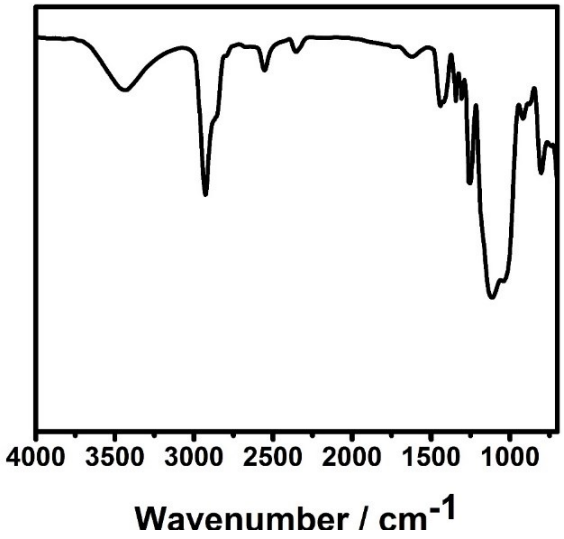



**Figure S11** The FTIR spectrum of POSS

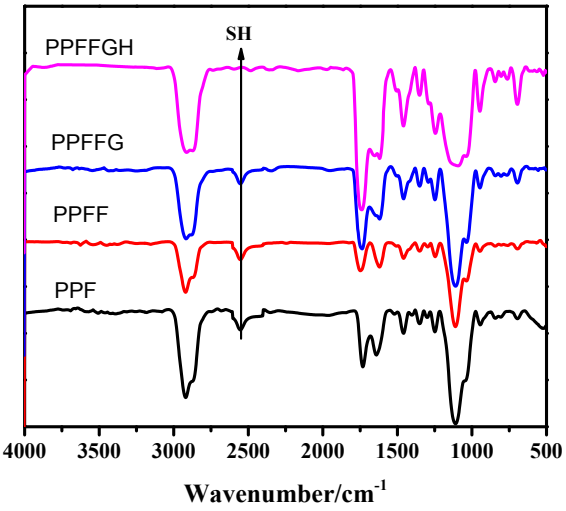



**Figure S12** The FTIR spectrum of multifunctional molecules synthesis process

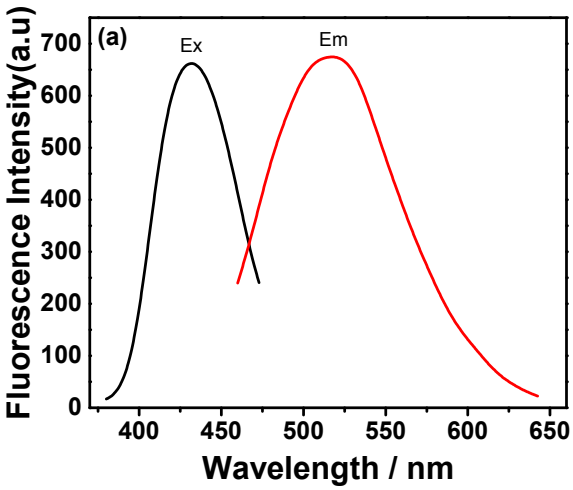



**Figure S13** Excitation and emission spectra of H1 in Ethanol/$H_2O$ (1/1, v/v) ( $\lambda_{ex}$ =430 nm),

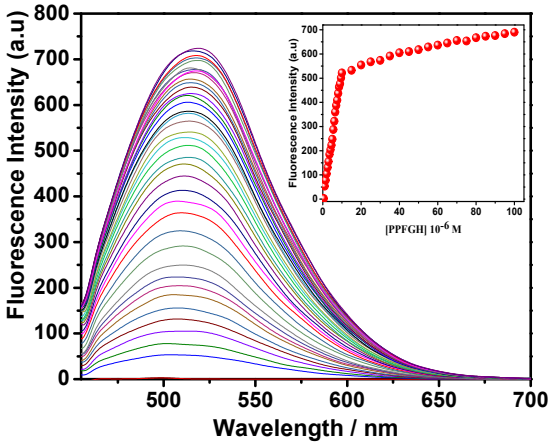



**Figure S14** The fluorescence emission spectra of H3 with different concentrations (0-100 μM) in EtOH/$H_2O$ (v/v, 1/1, $\lambda_{ex}$=440 nm),

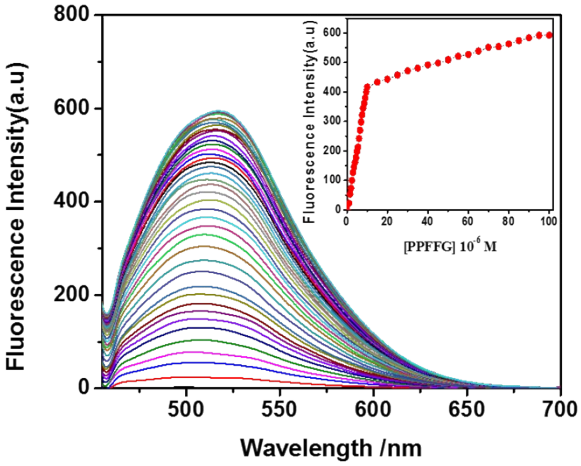



**Figure S15** The fluorescence emission spectra of H3 with different concentrations (0-100 μM) in EtOH/$H_2O$ (v/v, 1/1, $\lambda_{ex}$=440 nm),

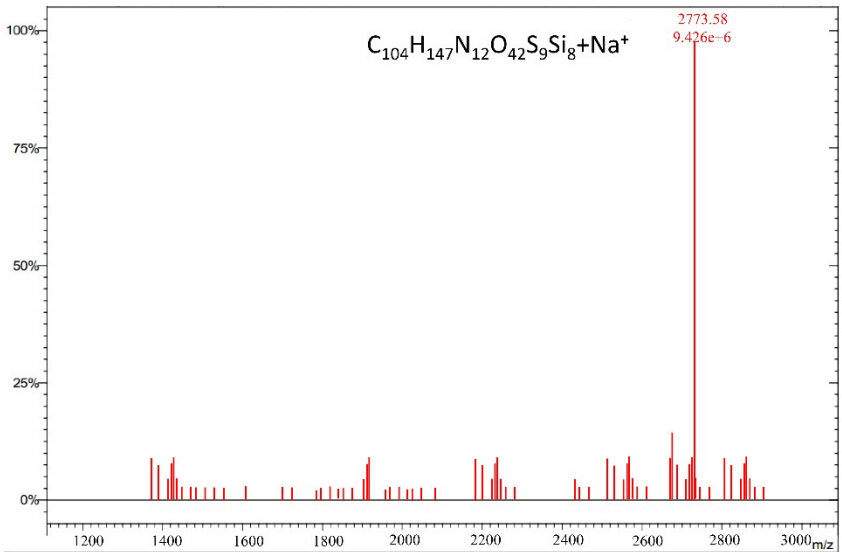



Figure S16 the MS of H1

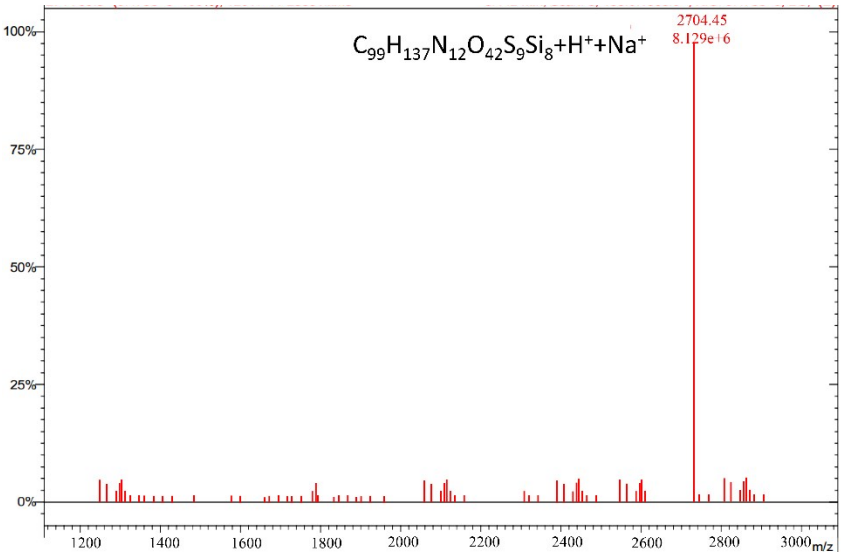



Figure S17 the MS of H2

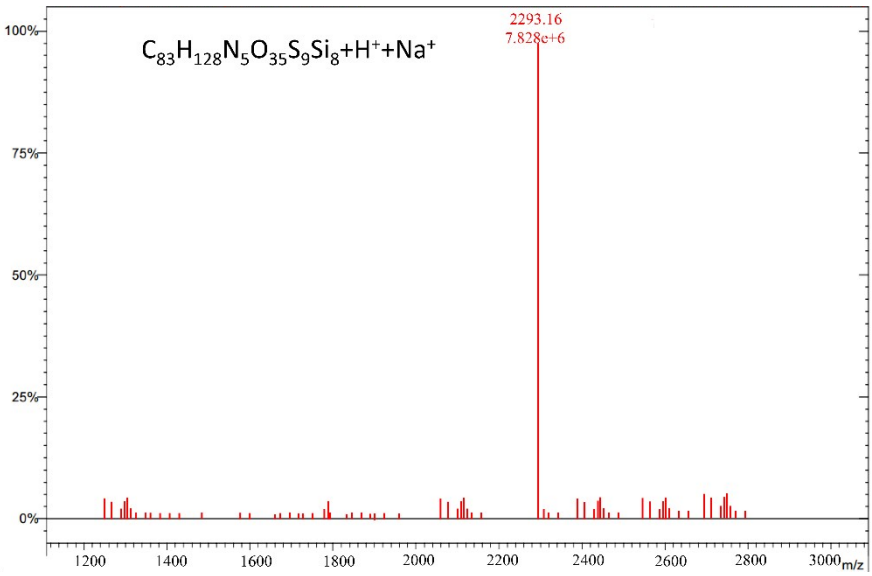



Figure S18 the MS of H3

## References

[1] S. Y. Guang, J. C. Tian, G. Wei, Z. Q. Yan, H. F. Pan, J. H. Feng, H. Y. Xu, talanta, 2017, 170, 89-96.

[2] G. Wei, G. Zhao, N. B. Lin, S. Y. Guang, H.Y. Xu, Colloid. Surface. A, 2020, 599, 124863-124870.