Electronic Supplementary Material (ESI) for Polymer Chemistry.

Supporting information

Multicolor mechanochromism of a multinetwork elastomer that can distinguish between low and high stress

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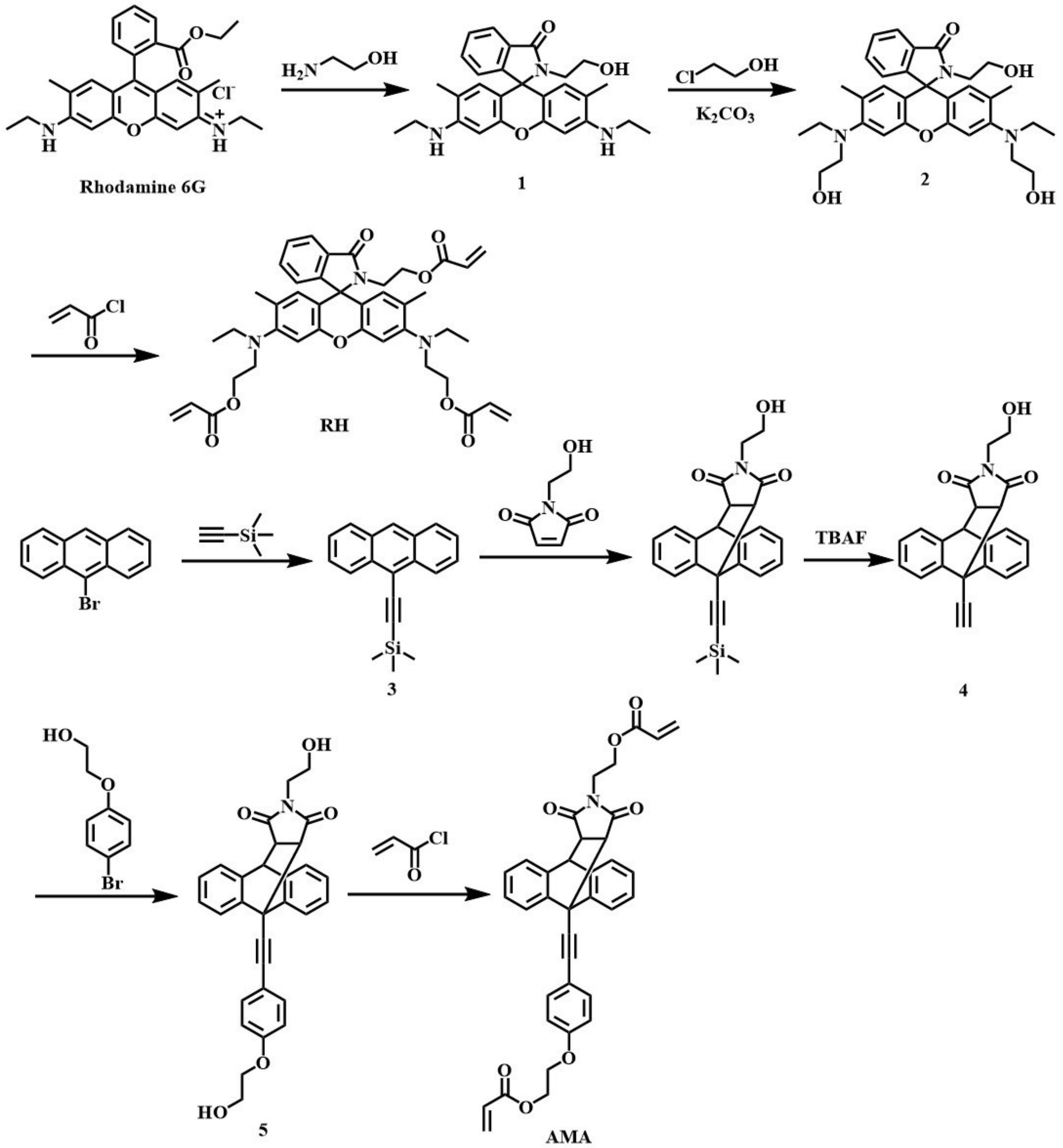
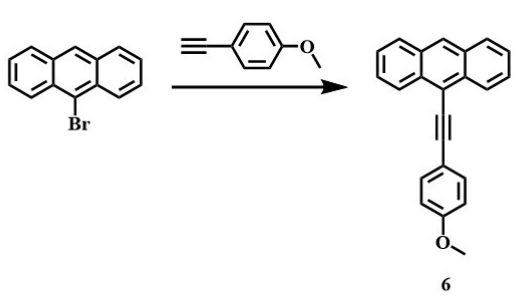
1. Experimental section

RH and **AMA** were synthesized according to **Scheme S1**.



Scheme S1. Synthetic routes for the **RH** and **AMA**.



Scheme S2. Synthetic route for the reference compound **6**

2. NMR spectra

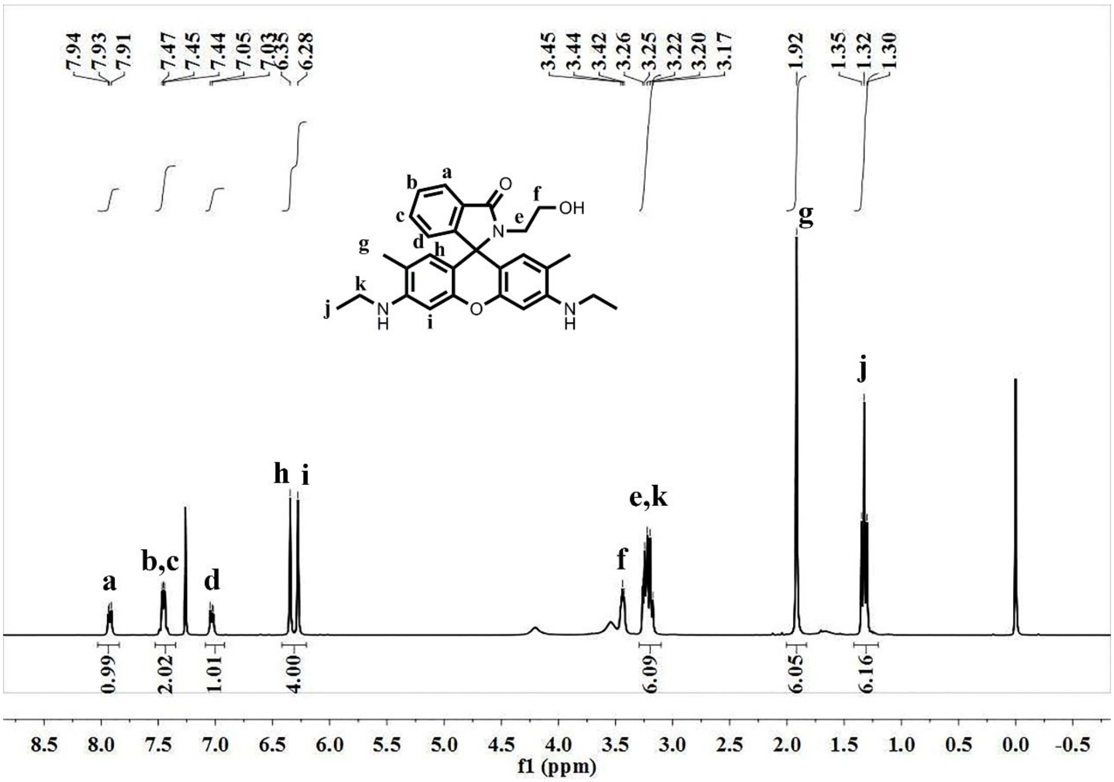


Figure S1. ^{1}H NMR spectrum of compound **1 i**n $CDCl_3$.

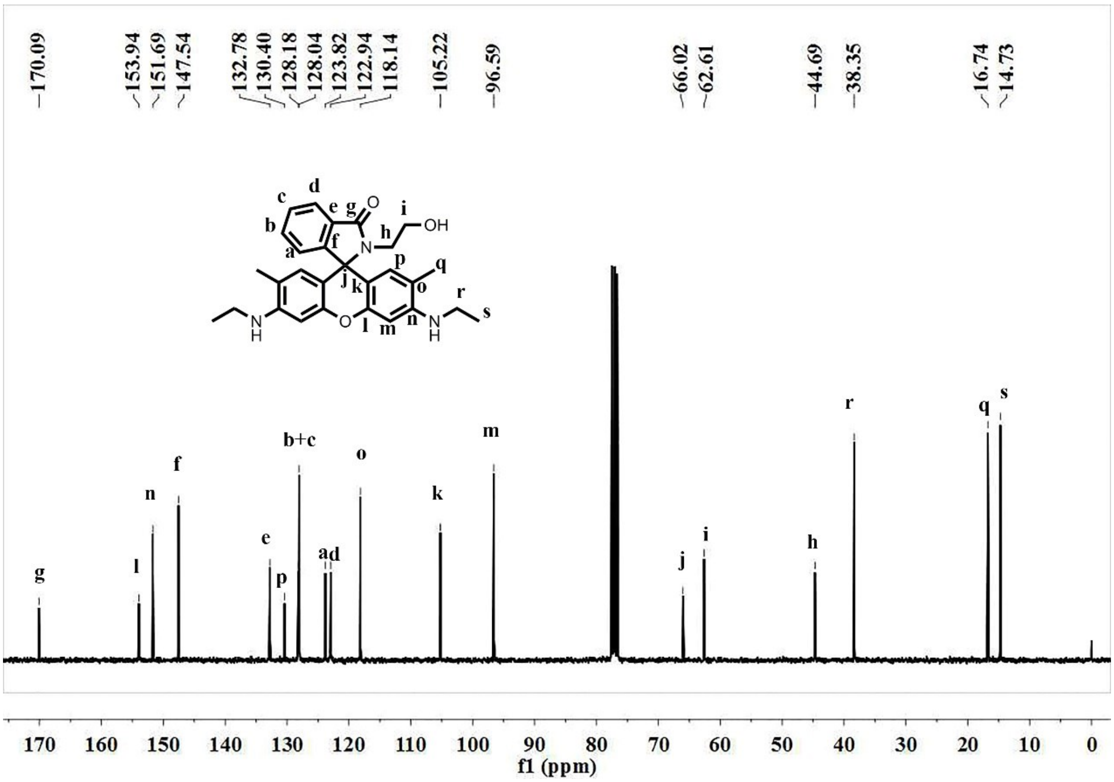


Figure S2. ^{13}C NMR spectrum of compound **1** in $CDCl_3$.

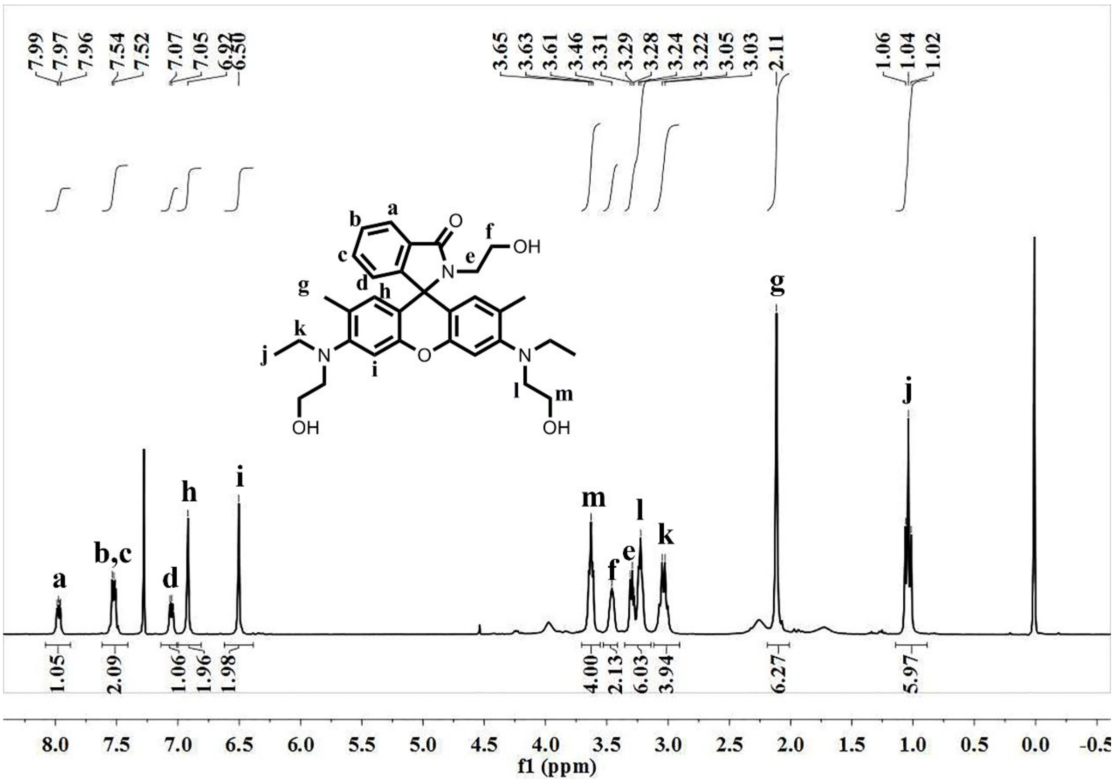


Figure S3. ^{1}H NMR spectrum of compound **2** in $CDCl_3$.

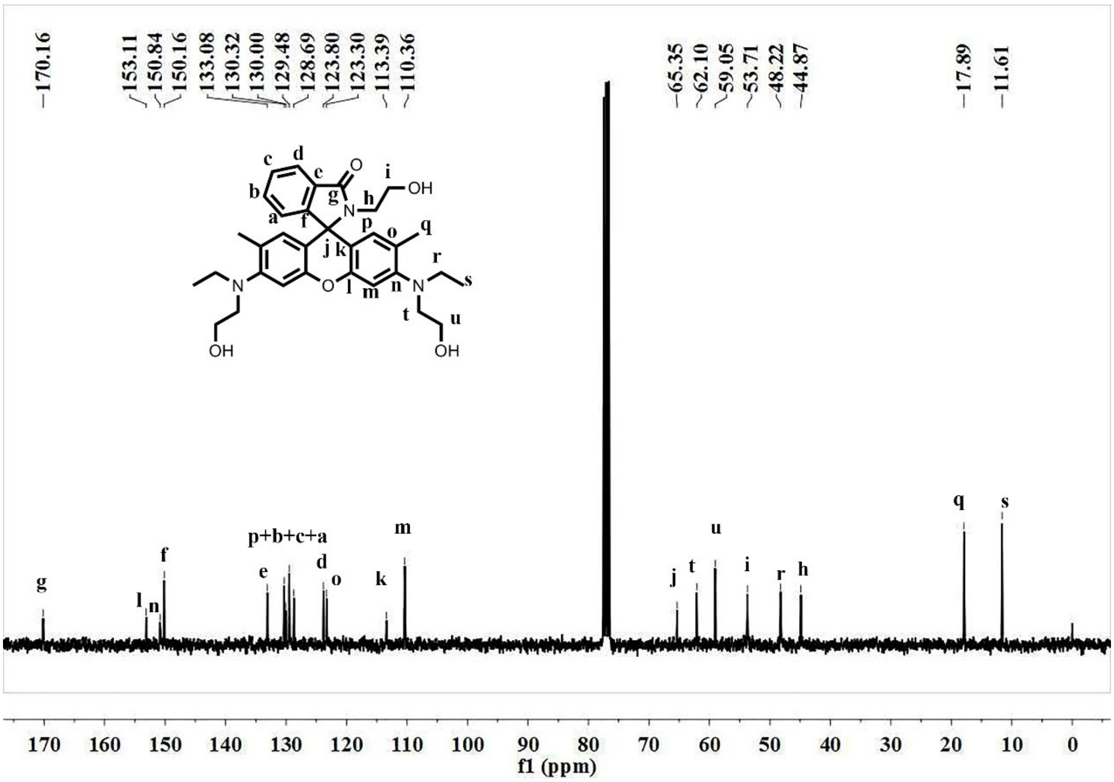


Figure S4. ^{13}C NMR spectrum of compound **2** in $CDCl_3$.

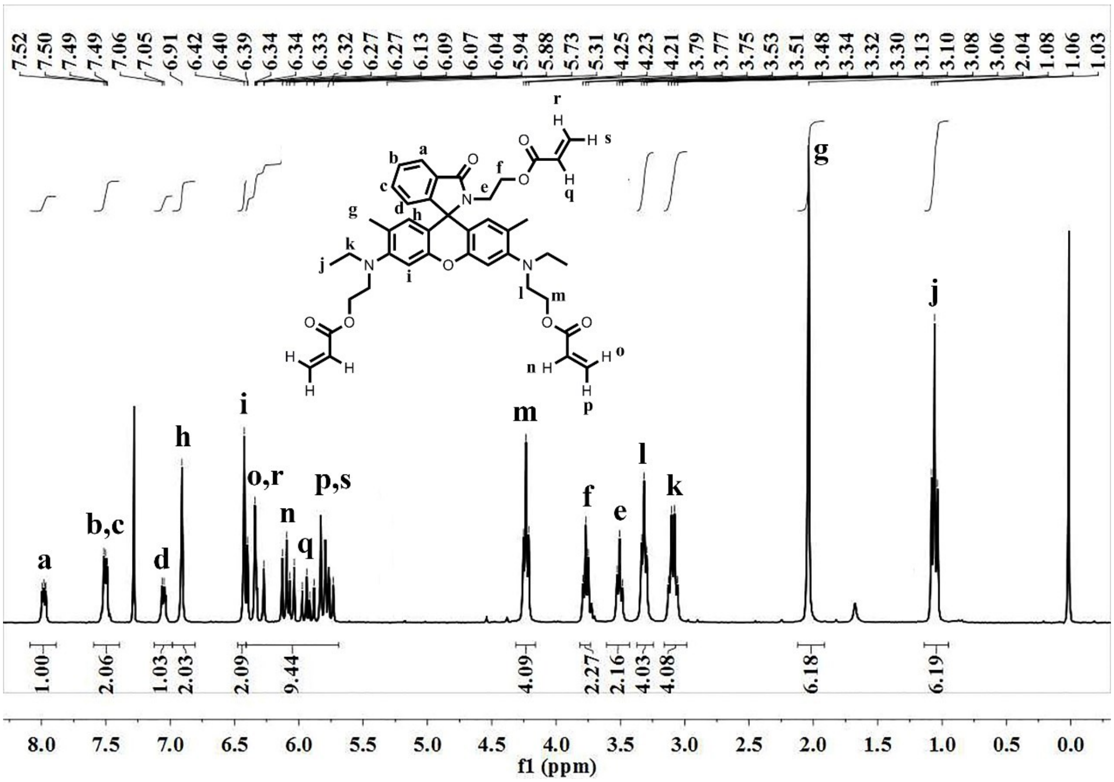


Figure S5. ^{1}H NMR spectrum of **RH** in $CDCl_3$.

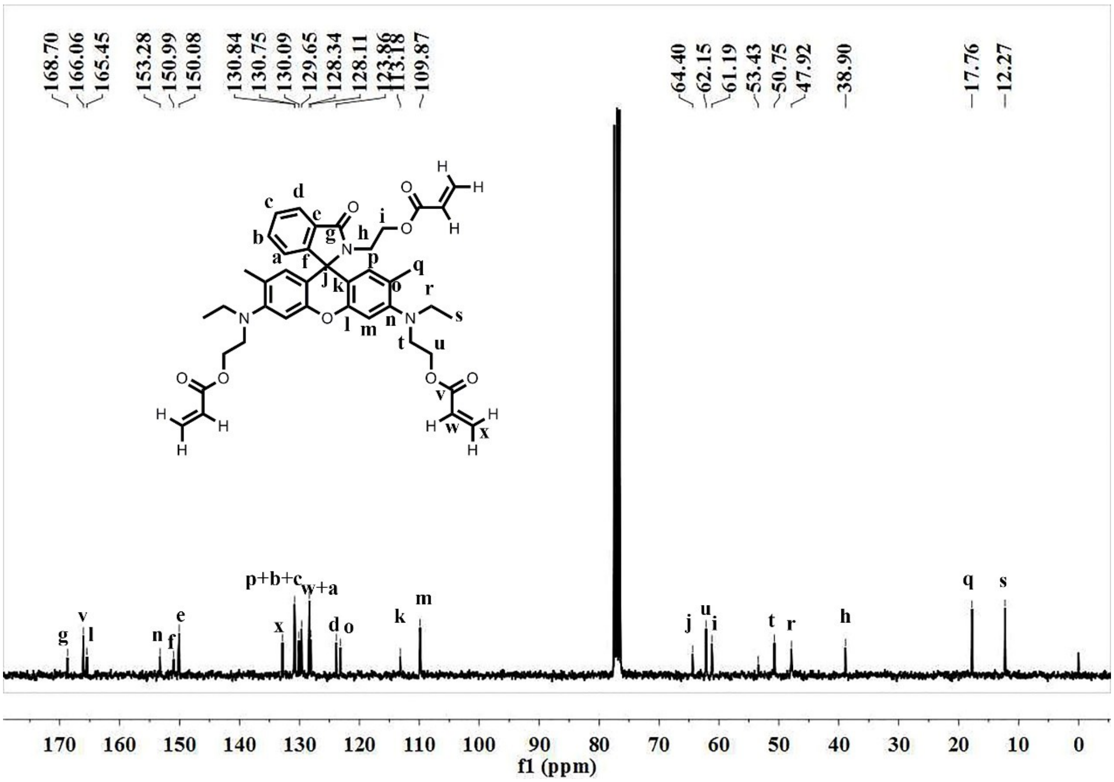


Figure S6. ^{13}C NMR spectrum of **RH** in $CDCl_3$.

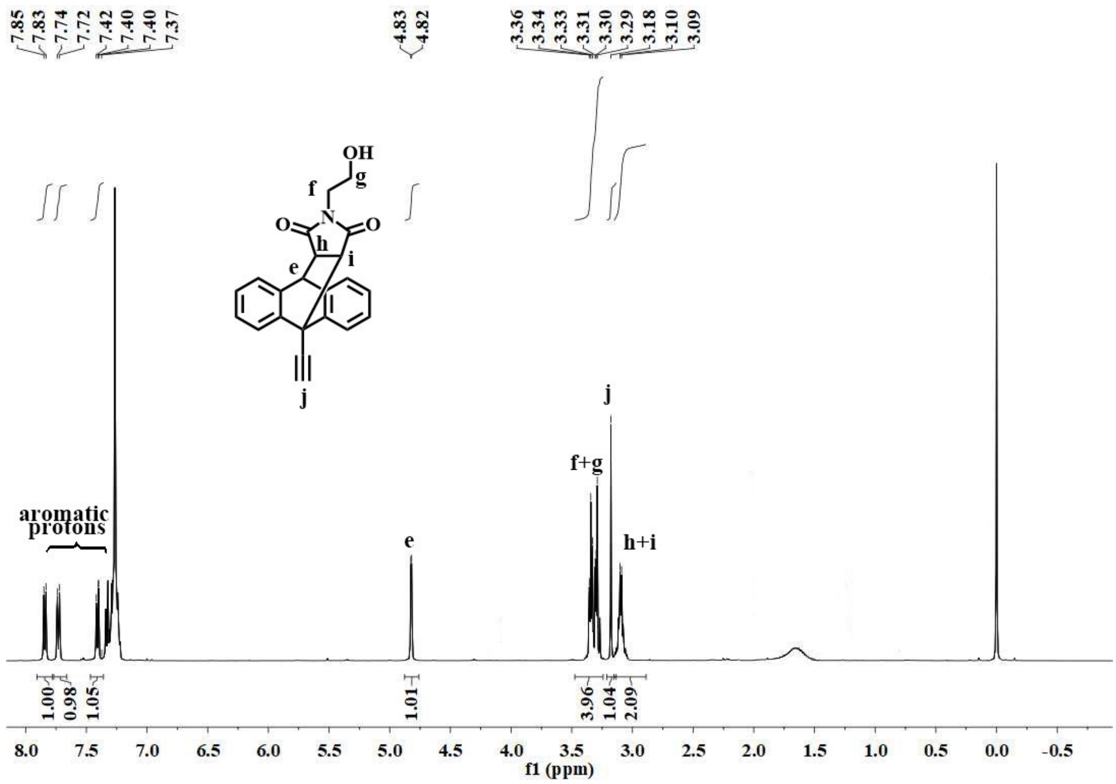


Figure S7. ^{1}H NMR spectrum of compound **4** in $CDCl_3$.

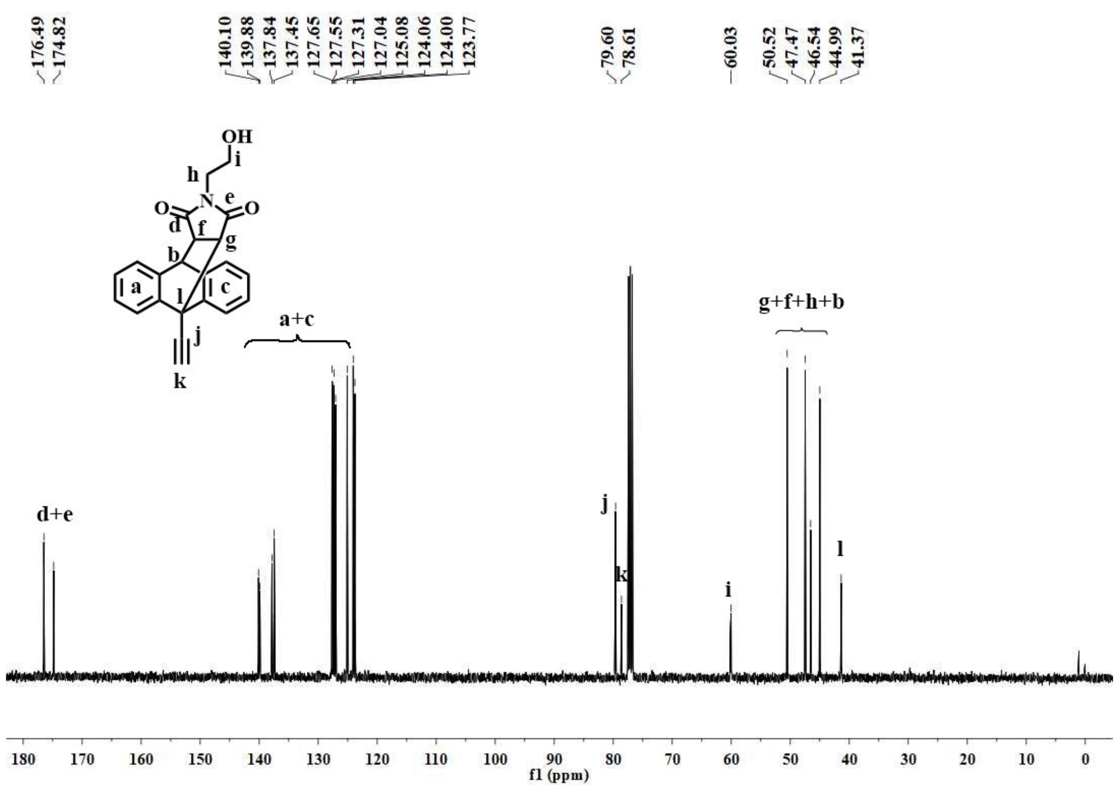


Figure S8. ^{13}C NMR spectrum of compound **4** in $CDCl_3$.

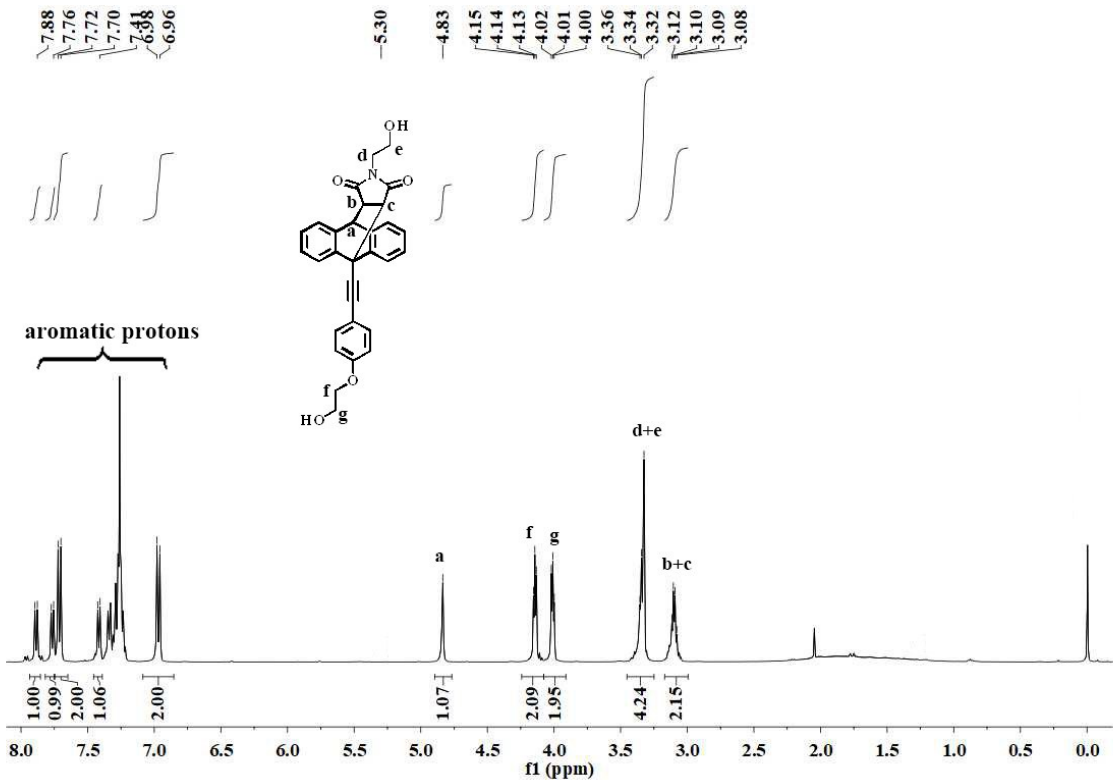


Figure S9. ^{1}H NMR spectrum of compound **5** in $CDCl_3$.

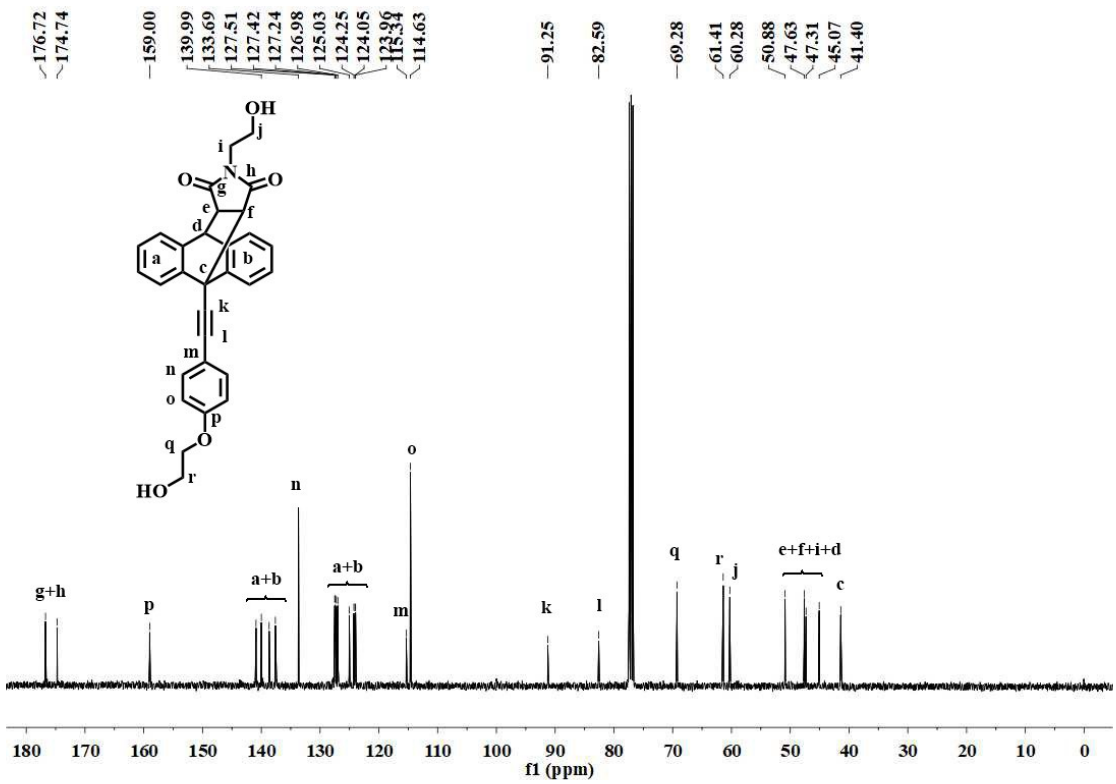


Figure S10. ^{13}C NMR spectrum of compound **5** in $CDCl_3$.

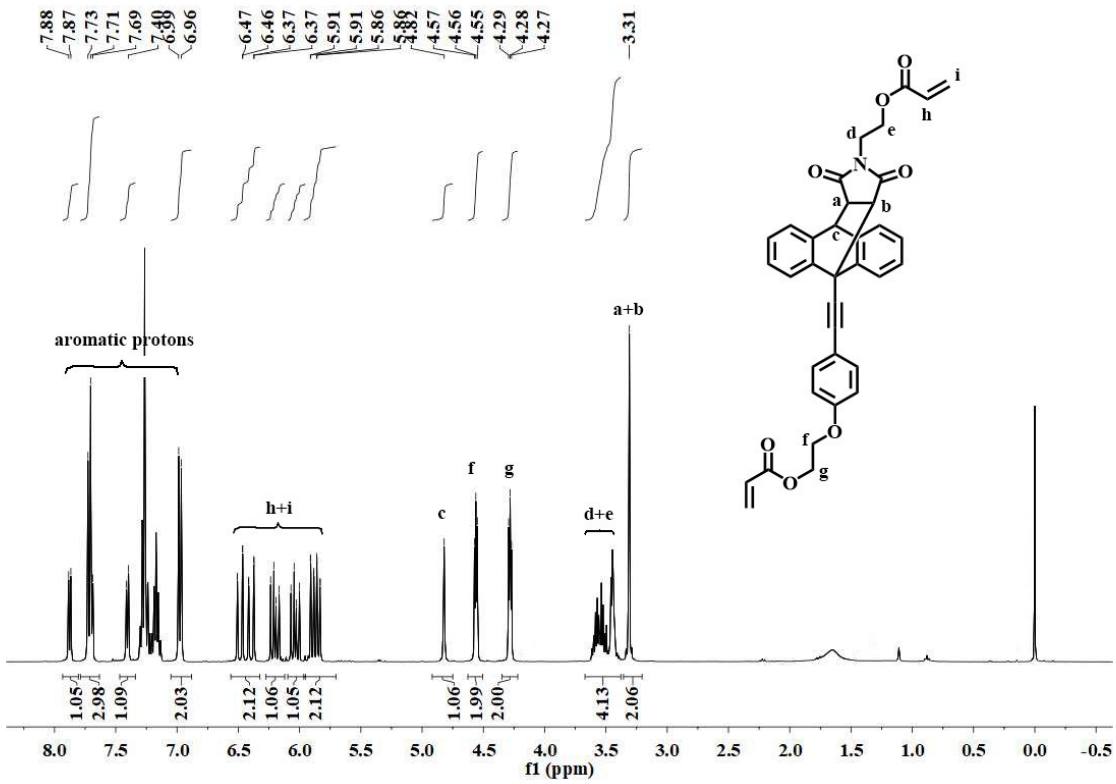


Figure S11. ^{1}H NMR spectrum of **AMA** in $CDCl_3$.

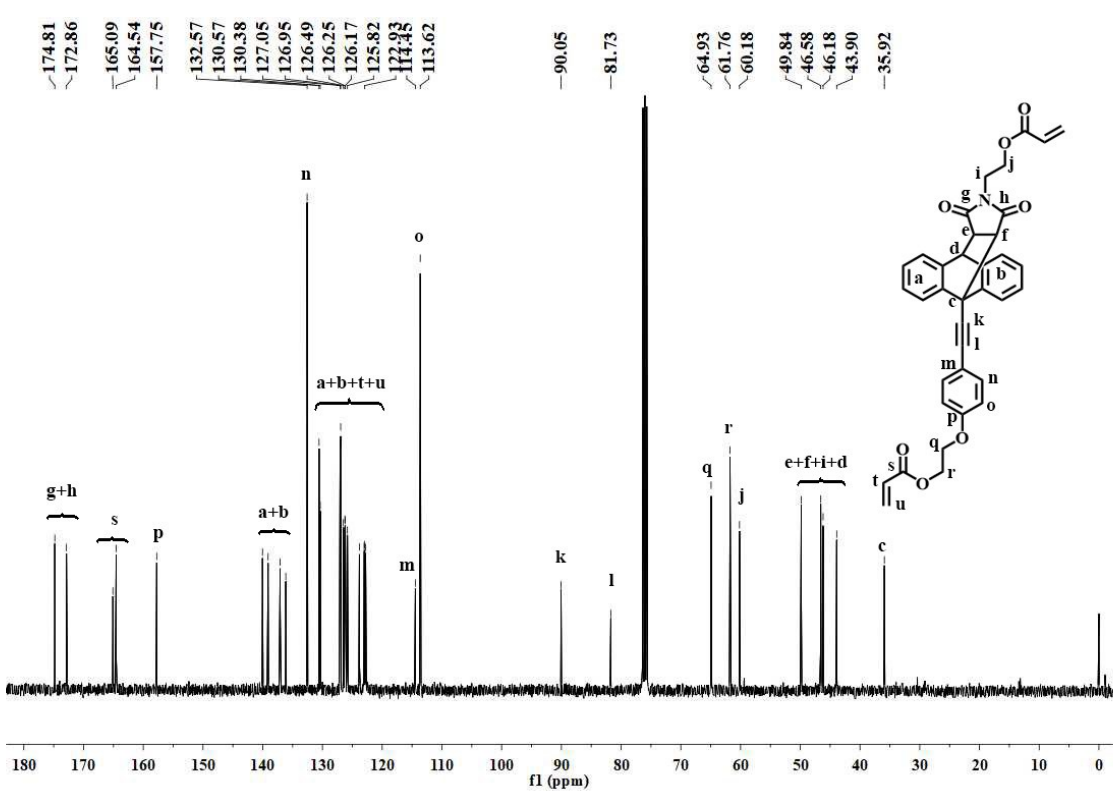


Figure S12. ^{13}C NMR spectrum of **AMA** in $CDCl_3$.

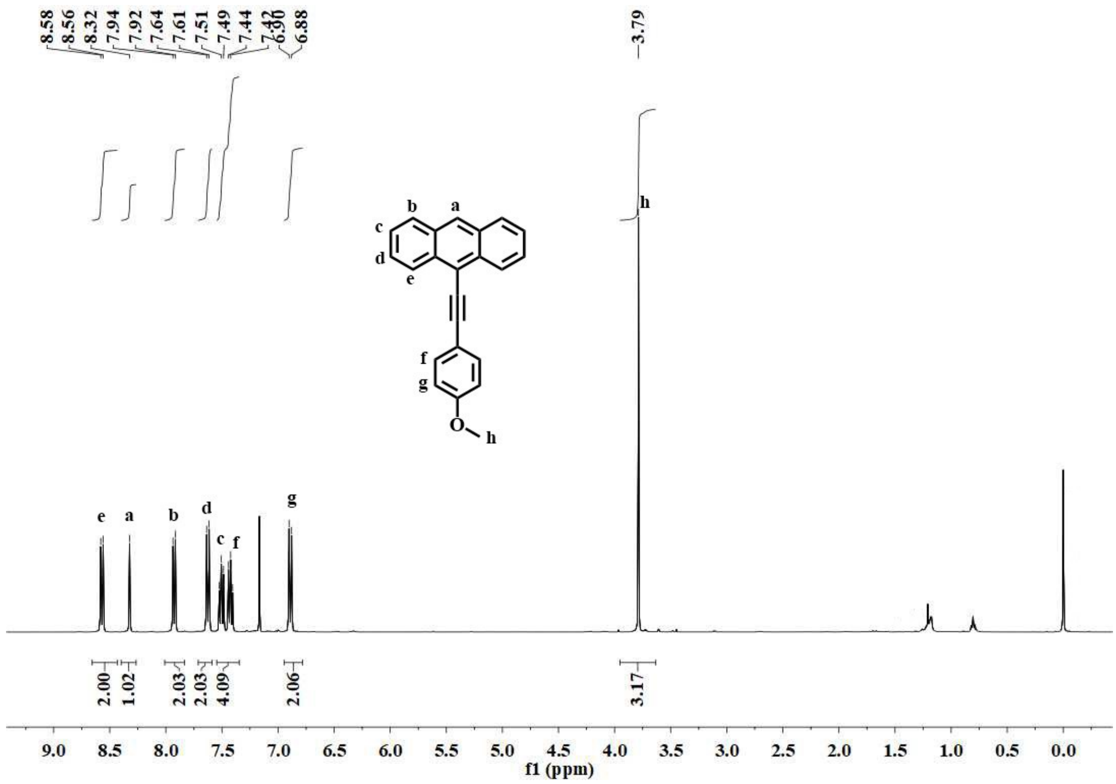


Figure S13. ^{1}H NMR spectrum of reference compound **6** in $CDCl_3$.

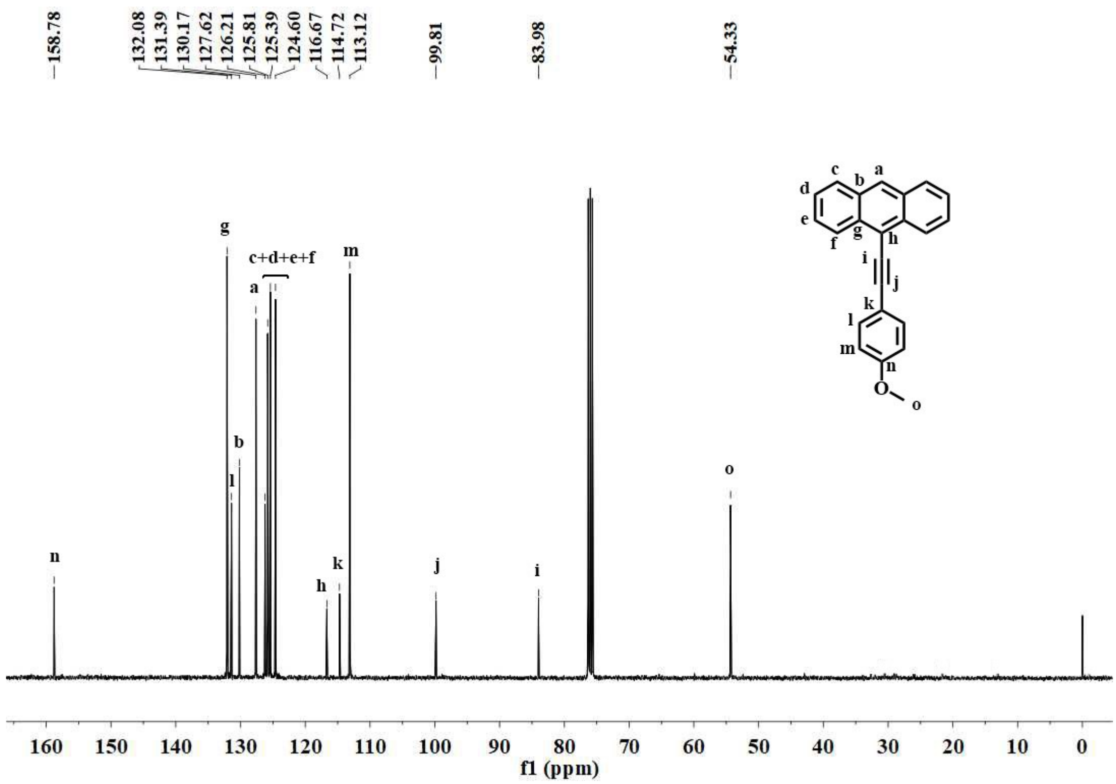


Figure S14. ^{13}C NMR spectrum of reference compound **6** in $CDCl_3$.

3. Mass spectra

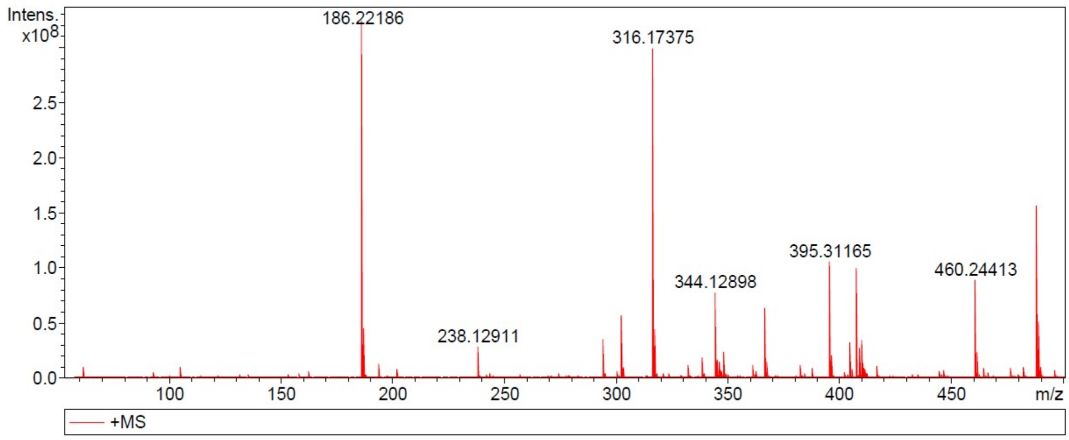


Figure S15. Mass spectrum of compound **4.**

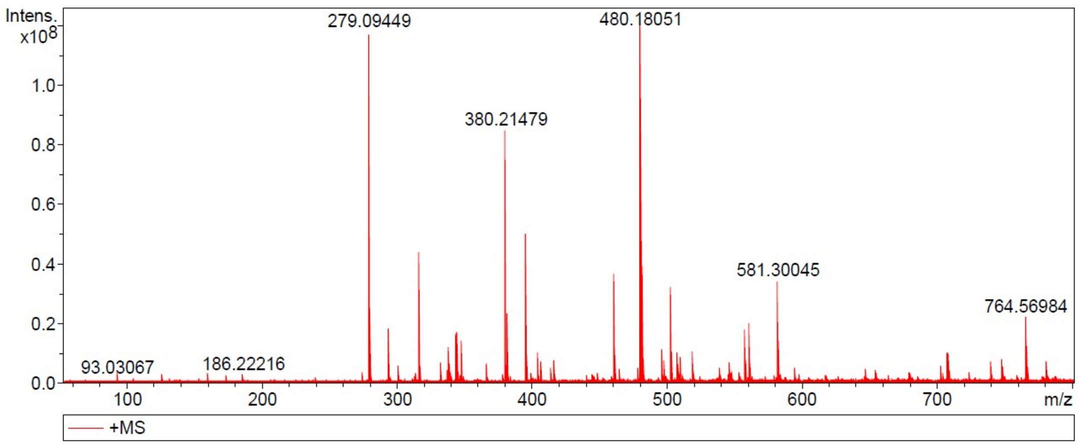


Figure S16. Mass spectrum of compound **5.**

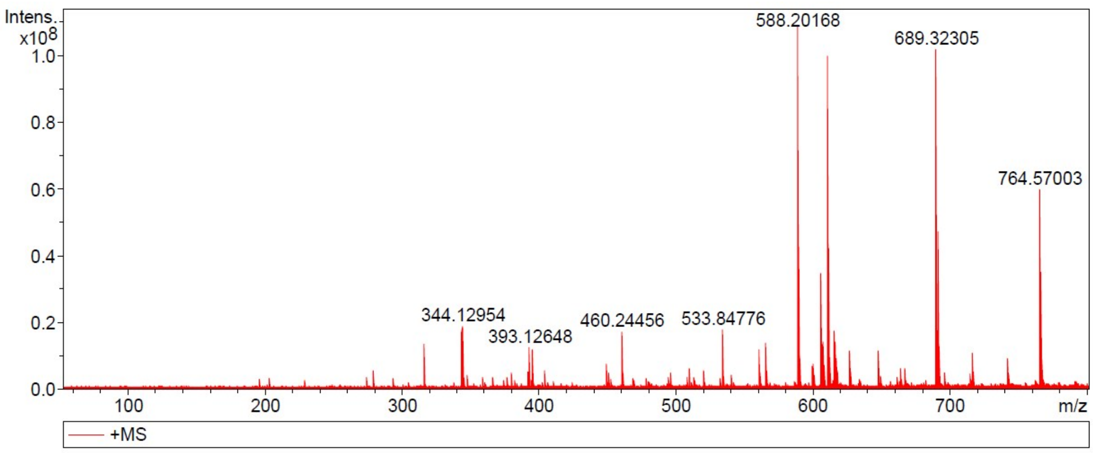


Figure S17. Mass spectrum of compound **AMA**.

4. Compositions of TN

Table S1. Compositions of TN

Sample	${}^{a}\lambda_{prestretch}$	ᵇWeight percentage			ᶜCrosslinker ratio		
		Swt %	Dwt %	Twt %	[AMA] /%	[RH] /%	[EGDMA] /%
$TN_{0.5AMA/0.4RH}$	2.8	8	15	77	0.04	0.06	0.039
$TN_{0.25AMA+0.25RH}$	3.2	6	30	64	0.015	0.015	0.047

[a] The prestretch of chains of the first network was determined using the thichnesses: $\lambda_{prestretch} = h/h_{SN}$. h_{SN} and h represented the thickness of first network elastomer and the final triple network elastomer.

[b] Swt, Dwt and Twt represented the weight percentage of the first, second and third network in the TN elastomer globally.

[c] [AMA], [RH] and [EGDMA] represented the corresponding crosslinker ratio in polymer globally.

5. IR spectra, DSC and TG profiles

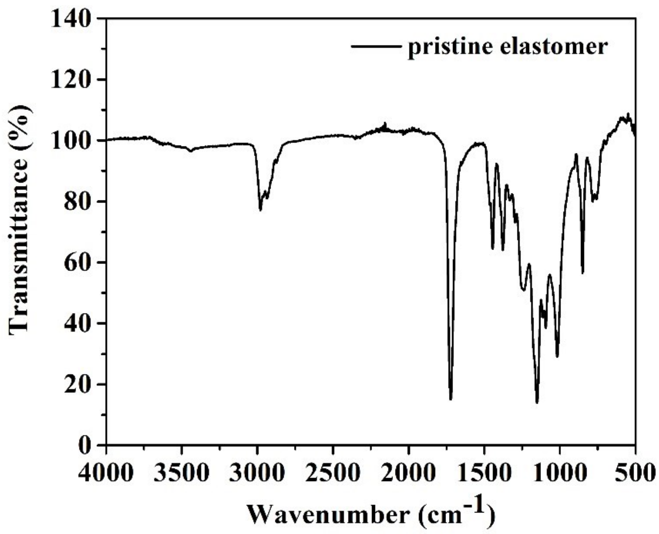


Figure S18. IR spectrum of pristine $TN_{0.5AMA/0.4RH}$ elastomer.

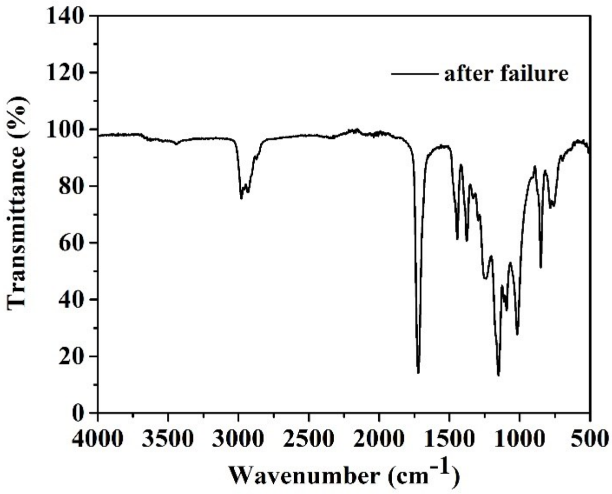


Figure S19. IR spectrum of $TN_{0.5AMA/0.4RH}$ elastomer after failure.

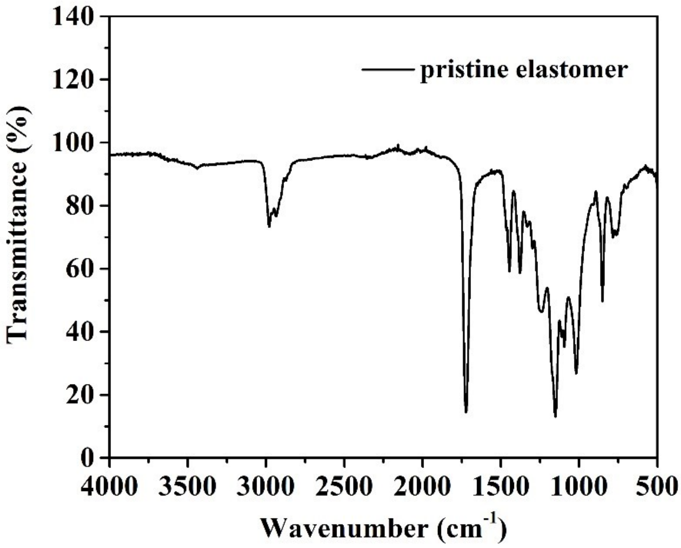


Figure S20. IR spectrum of pristine $TN_{0.25AMA+0.25RH}$ elastomer.

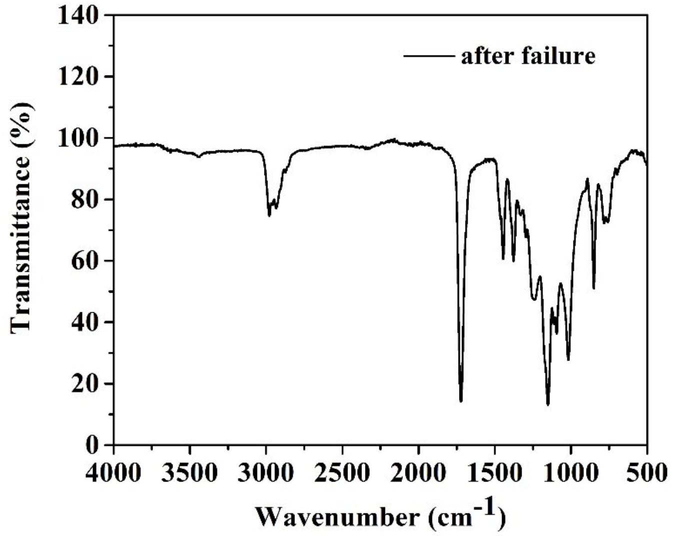


Figure S21. IR spectrum of $TN_{0.25AMA+0.25RH}$ elastomer after failure.

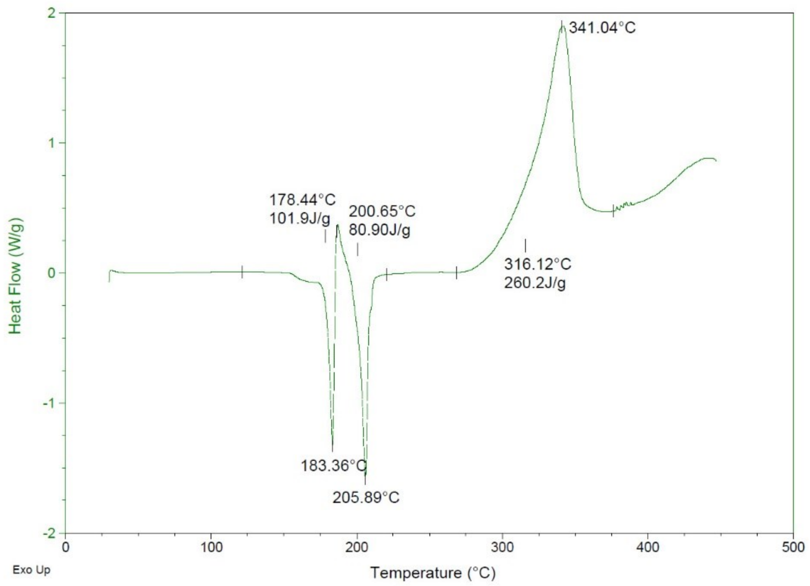


Figure S22. DSC curve of compound **AMA**.

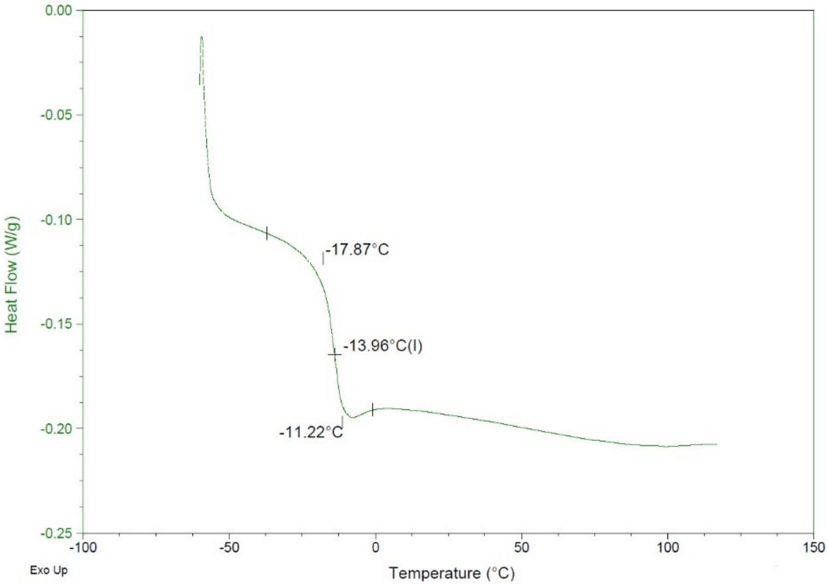


Figure S23. DSC curve of the $TN_{0.5AMA/0.4RH}$ elastomer.

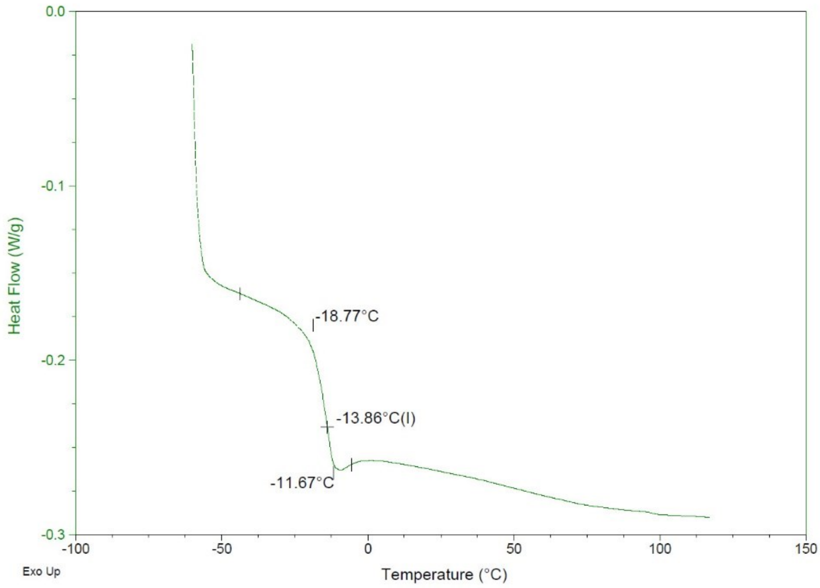


Figure S24. DSC curve of the $TN_{0.25AMA+0.25RH}$ elastomer.

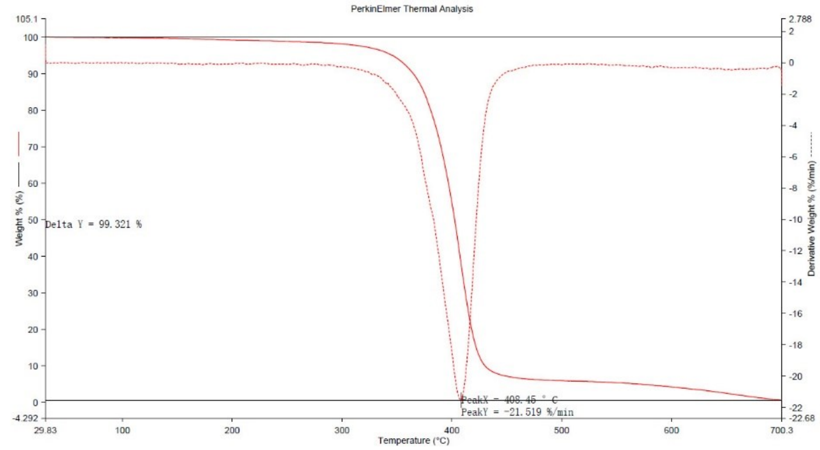


Figure S25. TG profile of the $TN_{0.5AMA/0.4RH}$ elastomer.

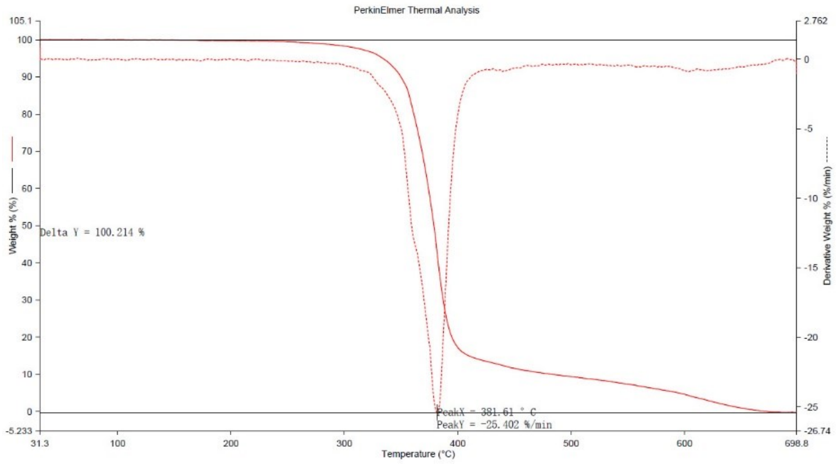


Figure S26. TG profile of the $TN_{0.25AMA+0.25RH}$ elastomer.

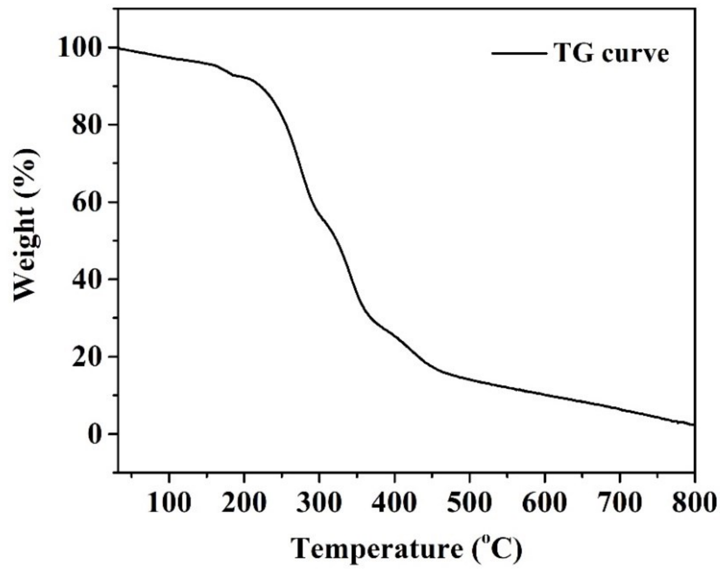


Figure S27. TG profile of the compound **AMA**.

6. Uniaxial tension of the elastomers

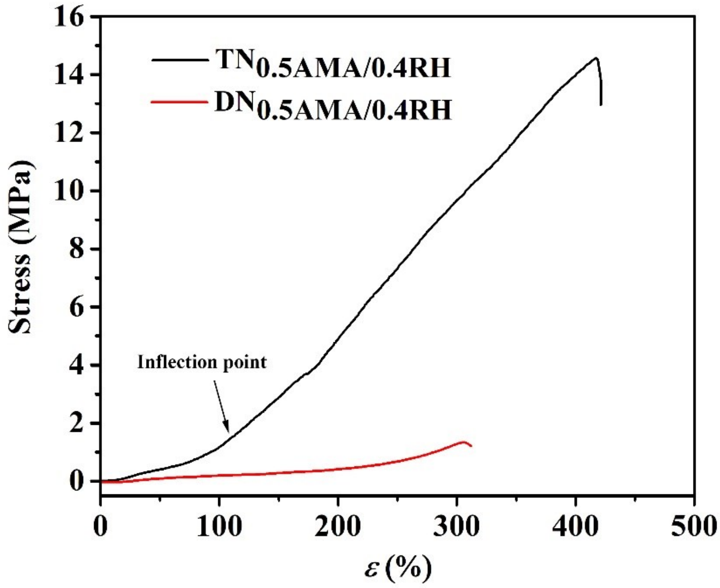


Figure S28. Stress-strain curves of the $TN_{0.5AMA/0.4RH}$ and $DN_{0.5AMA/0.4RH}$ elastomer.

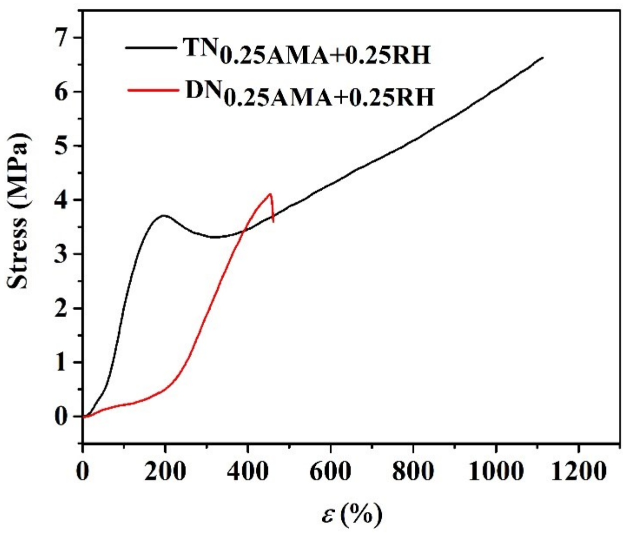


Figure S29. Stress-strain curves of the $TN_{0.25AMA+0.25RH}$ and $DN_{0.25AMA+0.25RH}$ elastomer.

Table S2. Mechanical properties of elastomers; shown are the Young's modulus *E* (Young's modulus was calculated by the slope of the stress-strain curve at the initial stage of the elongation), true stress at break, and strain at break (λ_{break})

Sample	T (ºC)	σ (MPa)	ε_{break}	E (MPa)
$TN_{0.5AMA/0.4RH}$	25	14.6	4.17	1.01
$DN_{0.5AMA/0.4RH}$	25	1.4	3.12	0.22
$TN_{0.25AMA+0.25RH}$	25	6.6	11.1	0.92
$DN_{0.25AMA+0.25RH}$	25	4.1	4.6	0.25

7. Fluorometric and ultraviolet analysis

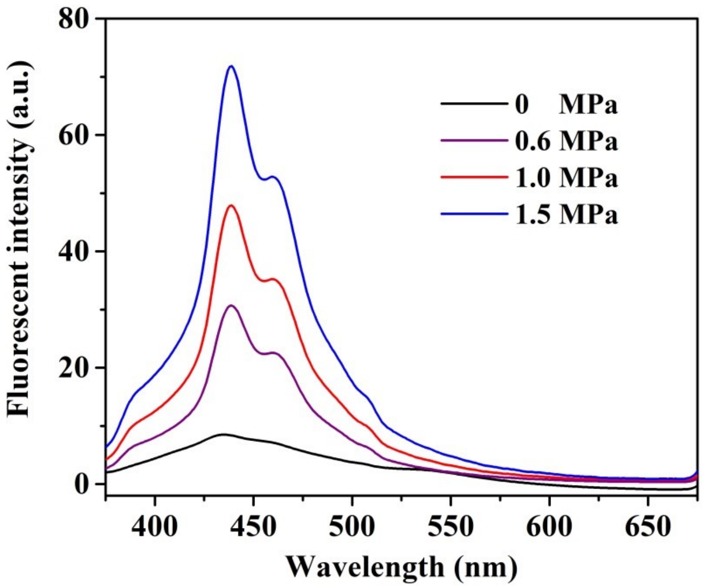


Figure S30. Fluorescent spectra of $TN_{0.5AMA/0.4RH}$ elastomer under low stress (＜1.8 MPa).

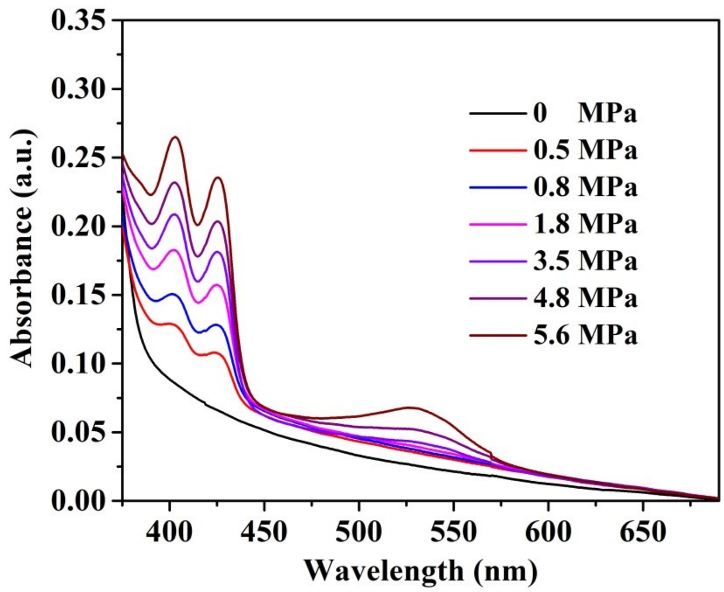


Figure S31. Absorption spectra of $TN_{0.5AMA/0.4RH}$ elastomer under different stress.

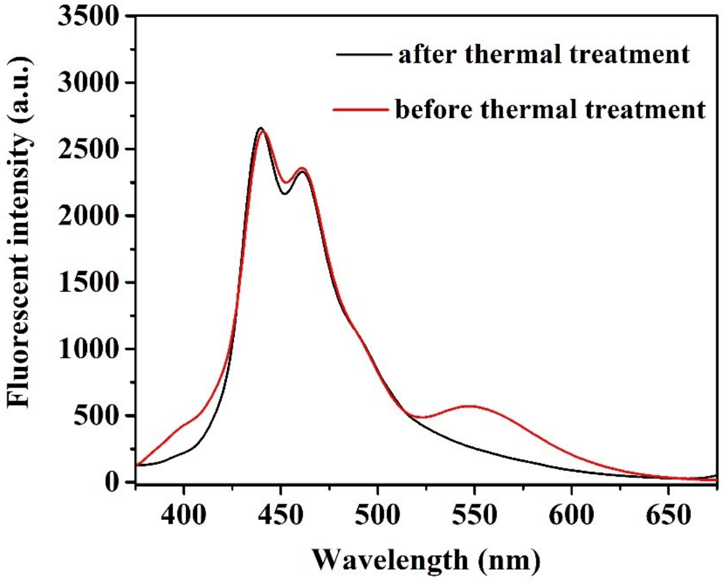


Figure S32. Fluorescent spectra of stretched $TN_{0.5AMA/0.4RH}$ elastomer before and after heat treatment (5 minutes at 60 °C).

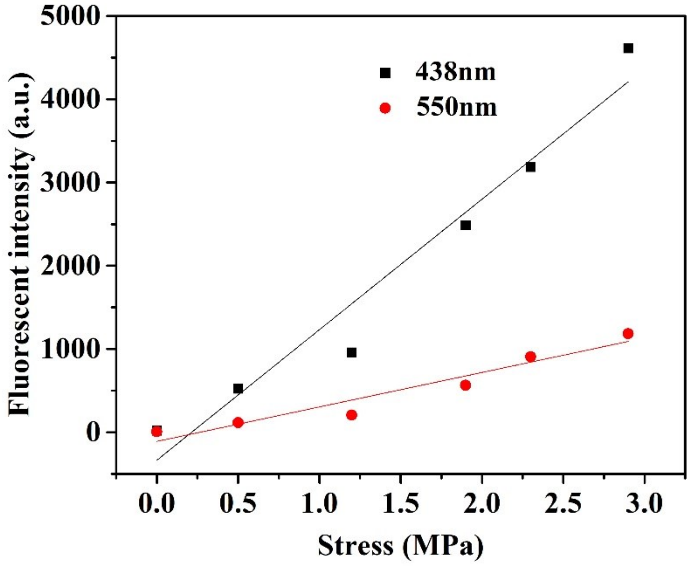


Figure S33. Fluorescent intensity of $TN_{0.25AMA+0.25RH}$ at 438 and 550 nm as a function of mechanical stress.

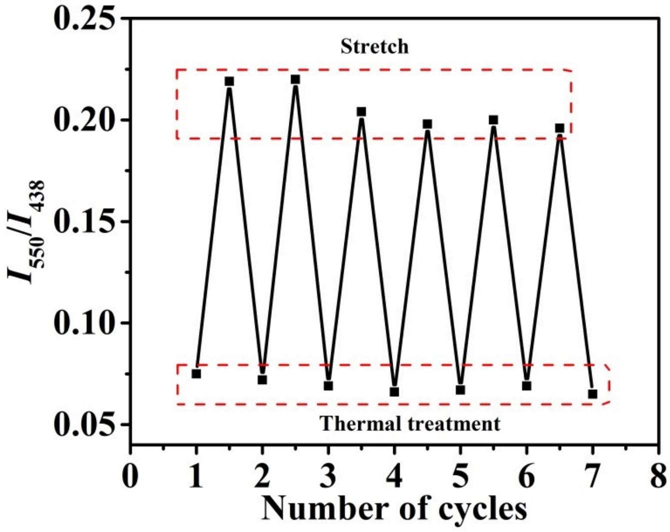


Figure S34. Relative intensities of the emission at 550 and 438 nm of $TN_{0.5AMA/0.4RH}$ elastomer as a function of the repeated cycle of stretch (the stress is 6 MPa) and thermal treatment (5 minutes at 60 ^oC)

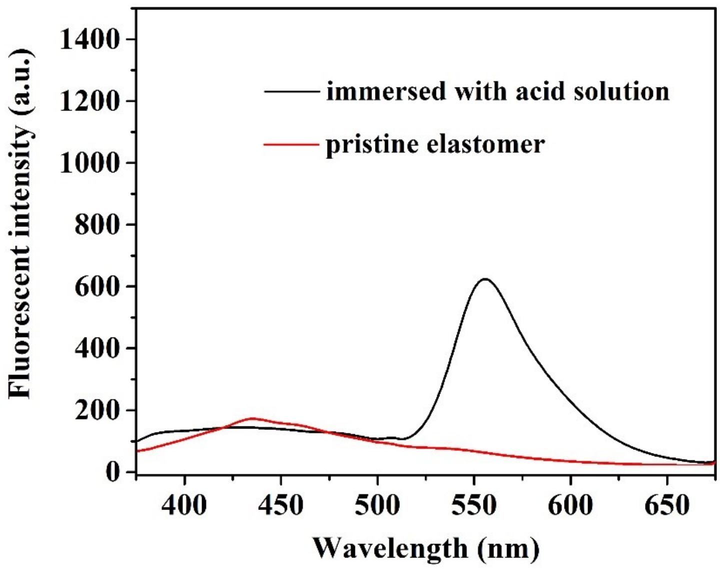


Figure S35. Fluorescent spectra of $TN_{0.5AMA/0.4RH}$ elastomer before and after immersed with methane sulfonic acid.

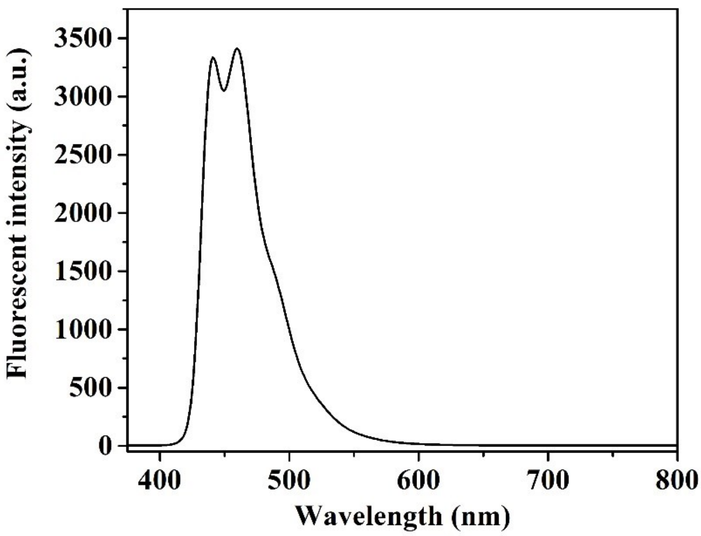


Figure S36. Fluorescent spectrum of the reference compound **6** in THF ($M=1\times10^{-5}$).

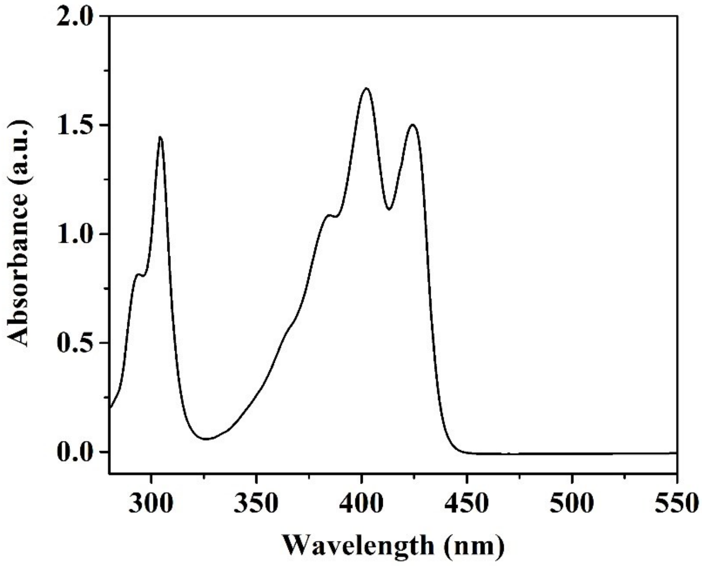


Figure S37. Absorption spectrum of the reference compound **6** in THF ($M=1\times10^{-5}$).

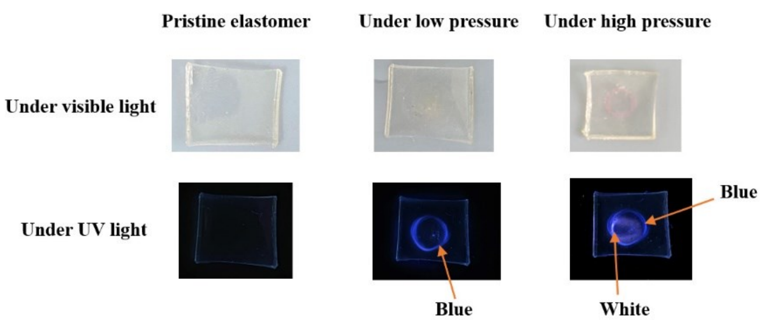


Figure S38. Images of the $TN_{0.5AMA/0.4RH}$ elastomer under relatively low and high pressure.