Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.


# Unlocking the effects of ancillary electron-donors on light absorption and charge recombination in phenanthrocarbazole dye-sensitized solar cells

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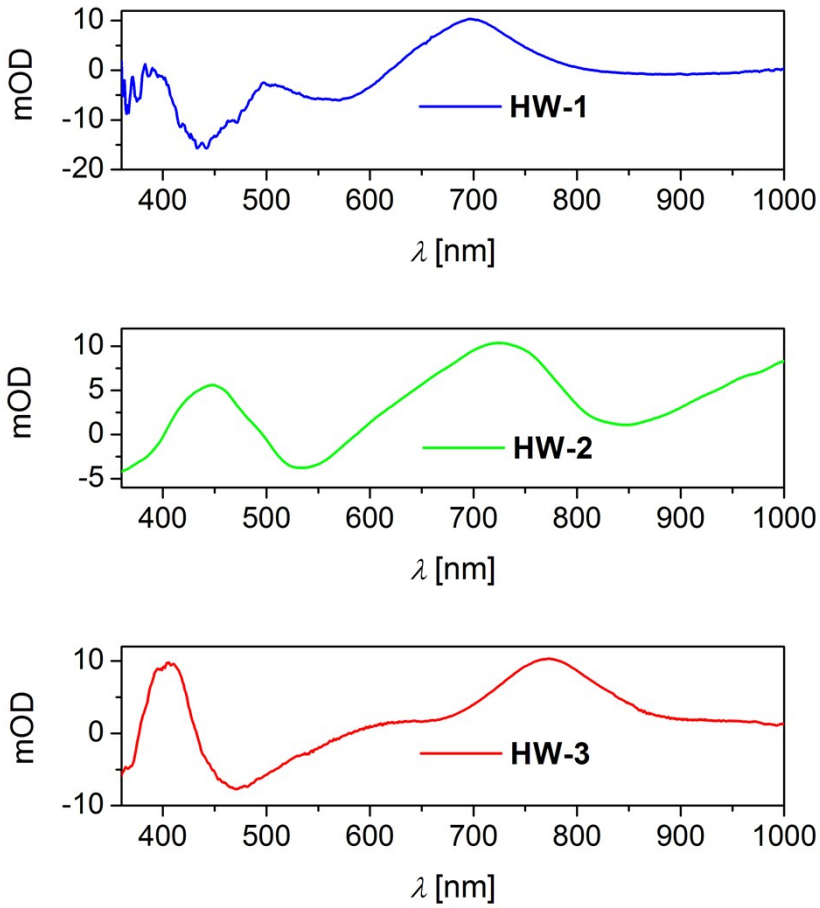


**Fig. S1** Wavelength-dependent absorption change upon applying a positive potential bias to a 1.2-μm-thick, dye-grafted titania film immersed in EMITFSI.

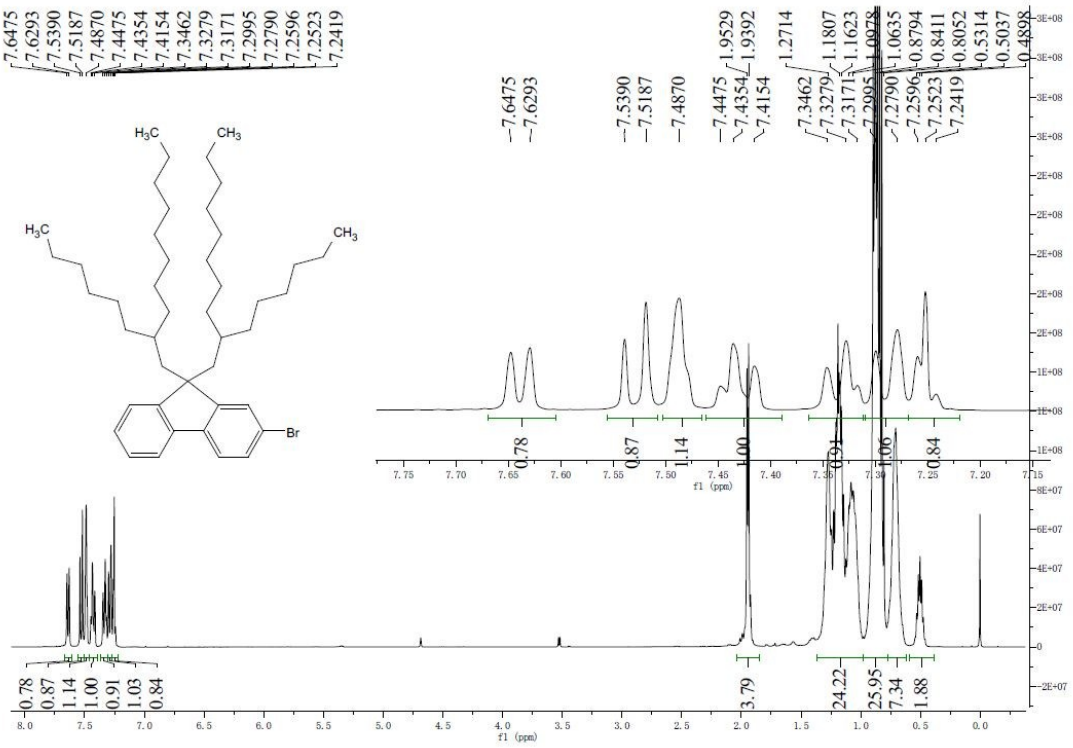


**Fig. S2** The $^{1}H$ NMR (400 MHz) of **3** in $CDCl_3$.

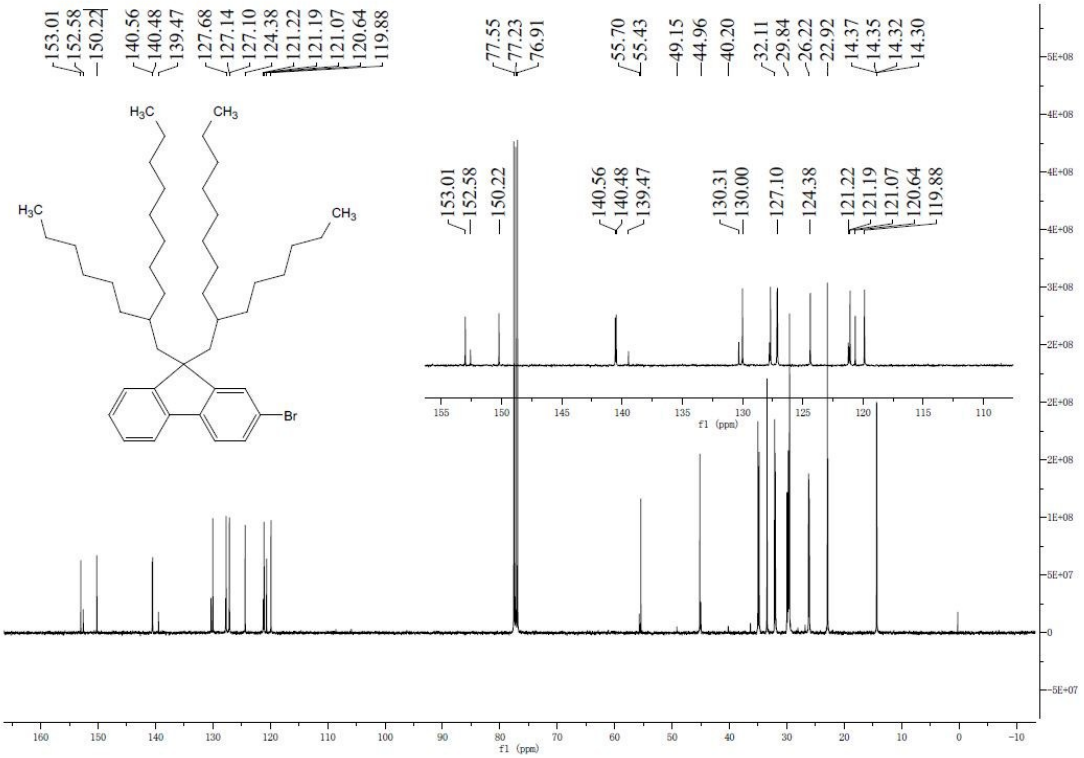


**Fig. S3** The $^{13}C$ NMR (100 MHz) of **3** in $CDCl_3$.

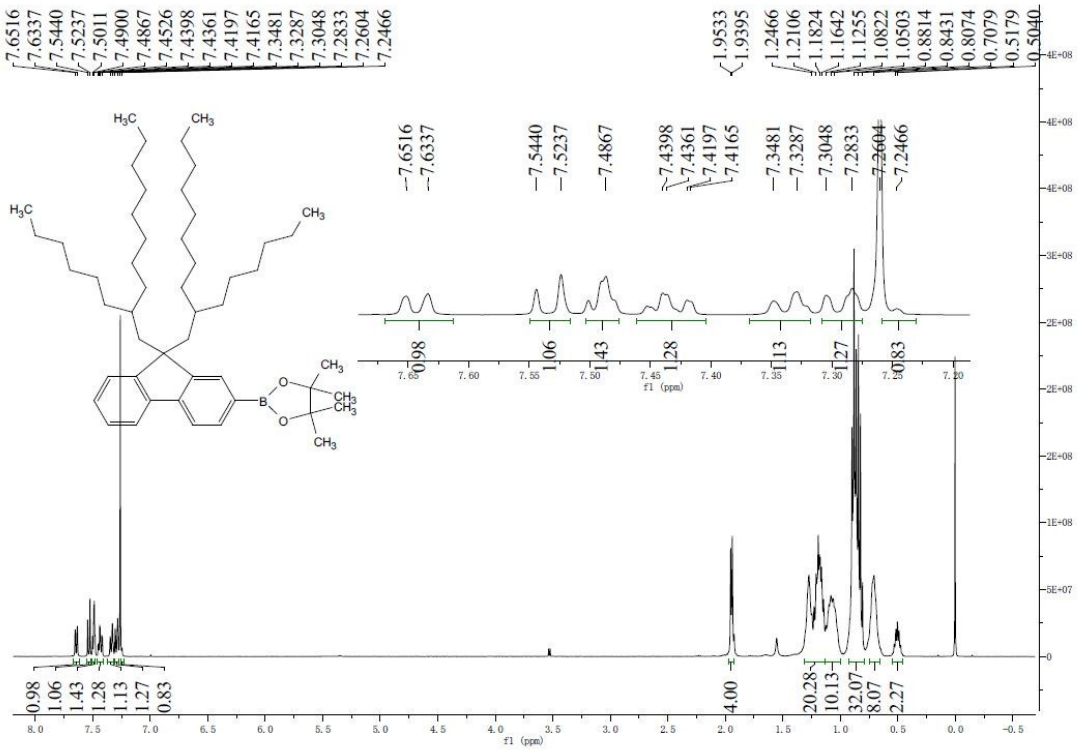

**Fig. S4** The $^{1}H$ NMR (400 MHz) of **4** in $CDCl_3$.

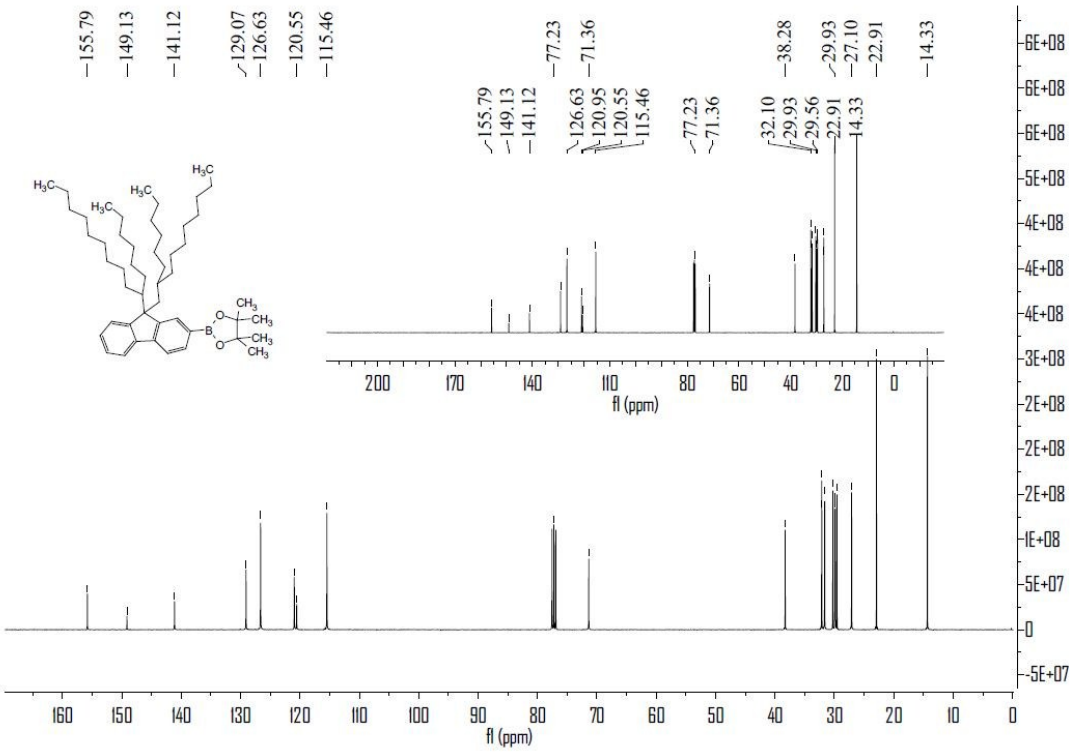


**Fig. S5** The $^{13}C$ NMR (100 MHz) of **4** in $CDCl_3$.

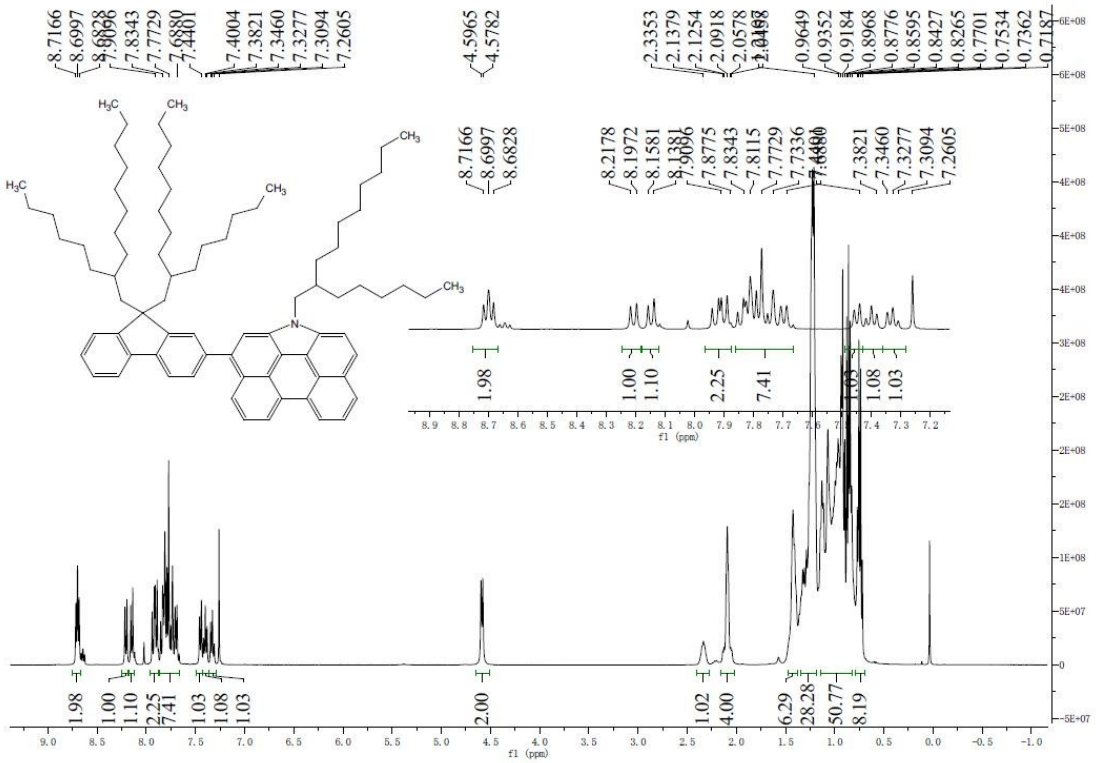

**Fig. S6** The $^{1}H$ NMR (400 MHz) of **5** in $CDCl_3$.

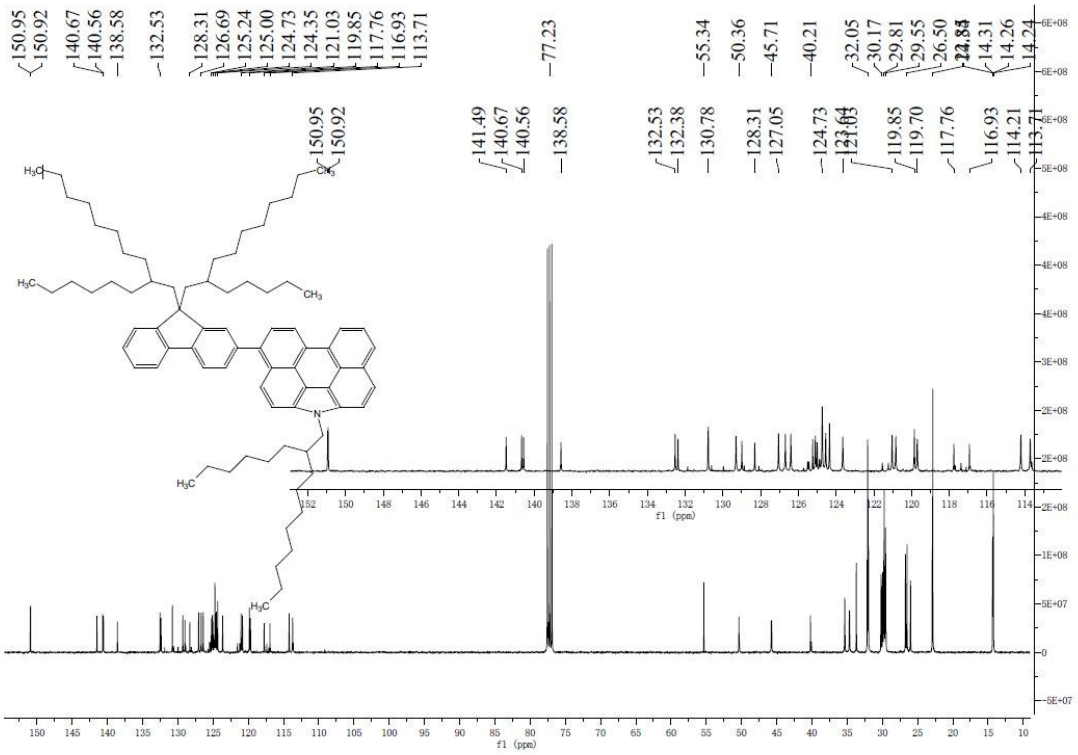

**Fig. S7** The $^{13}C$ NMR (100 MHz) of **5** in $CDCl_3$.

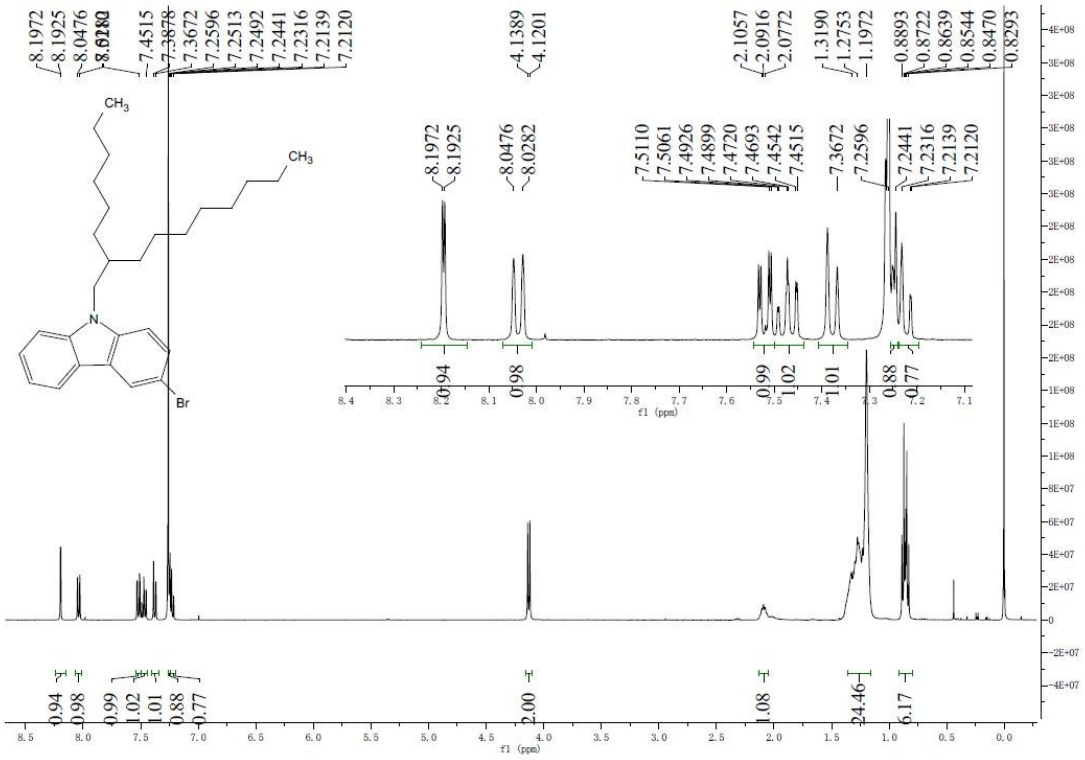

**Fig. S8** The $^{1}$H NMR (400 MHz) of **7** in $CDCl_3$.

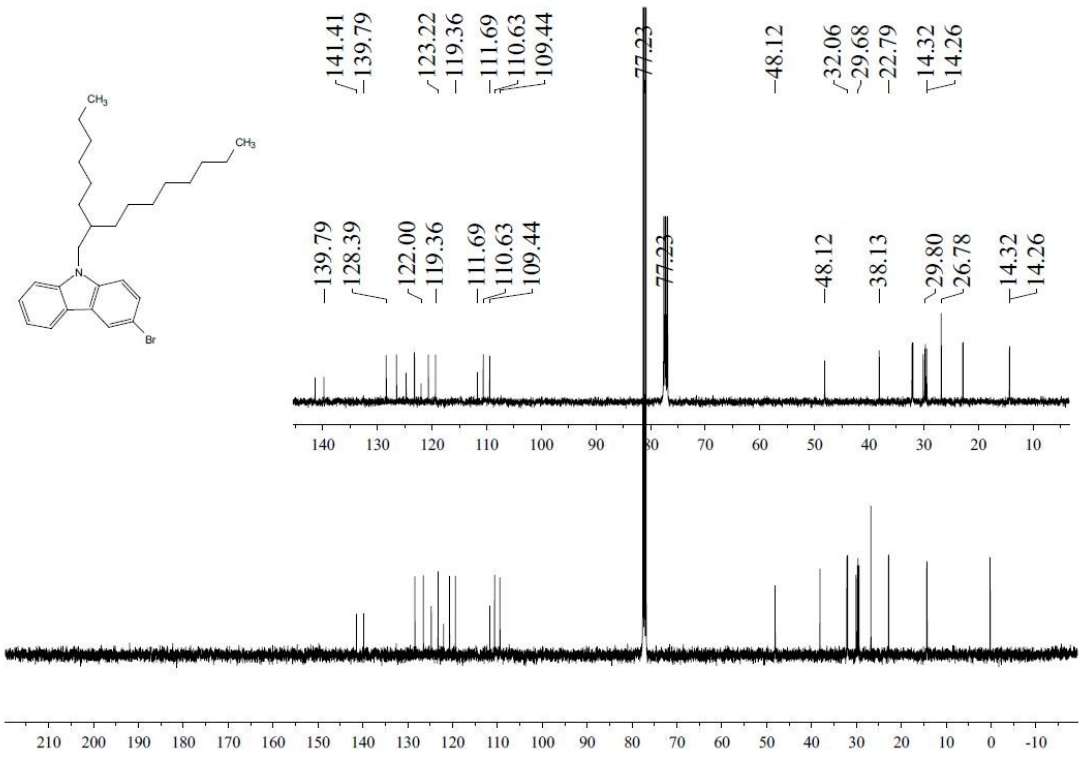


**Fig. S9** The $^{13}C$ NMR (100 MHz) of **7** in $CDCl_3$.

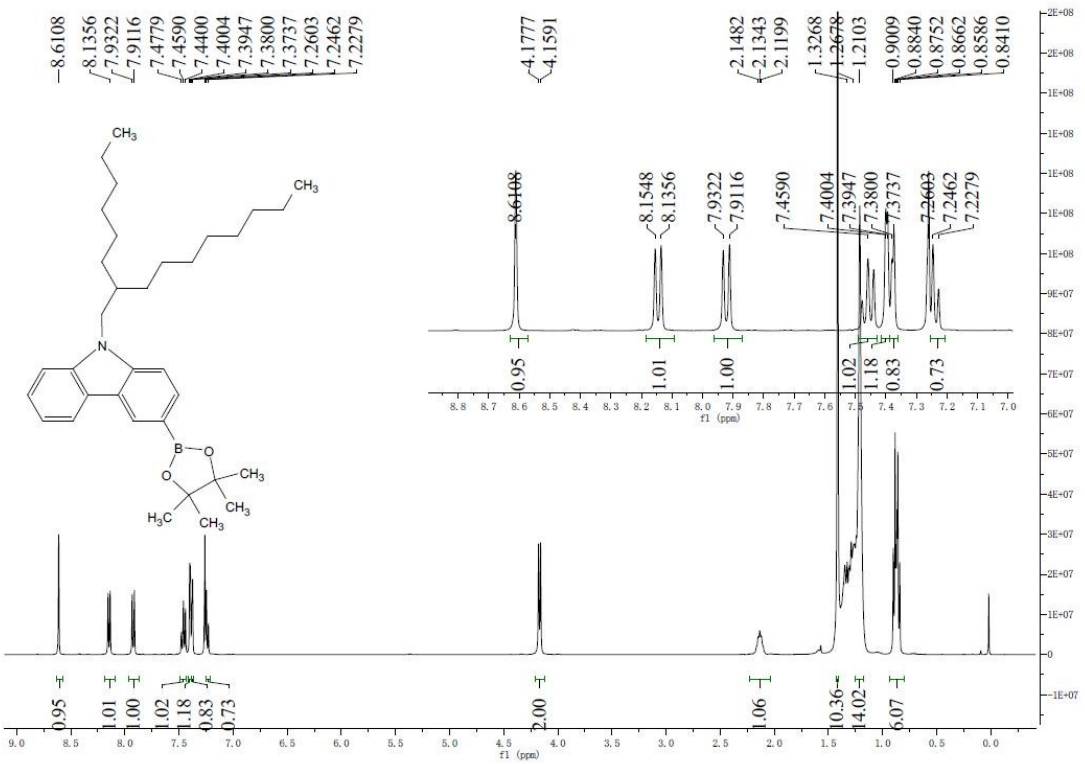

**Fig. S10** The $^{1}H$ NMR (400 MHz) of **8** in $CDCl_3$.

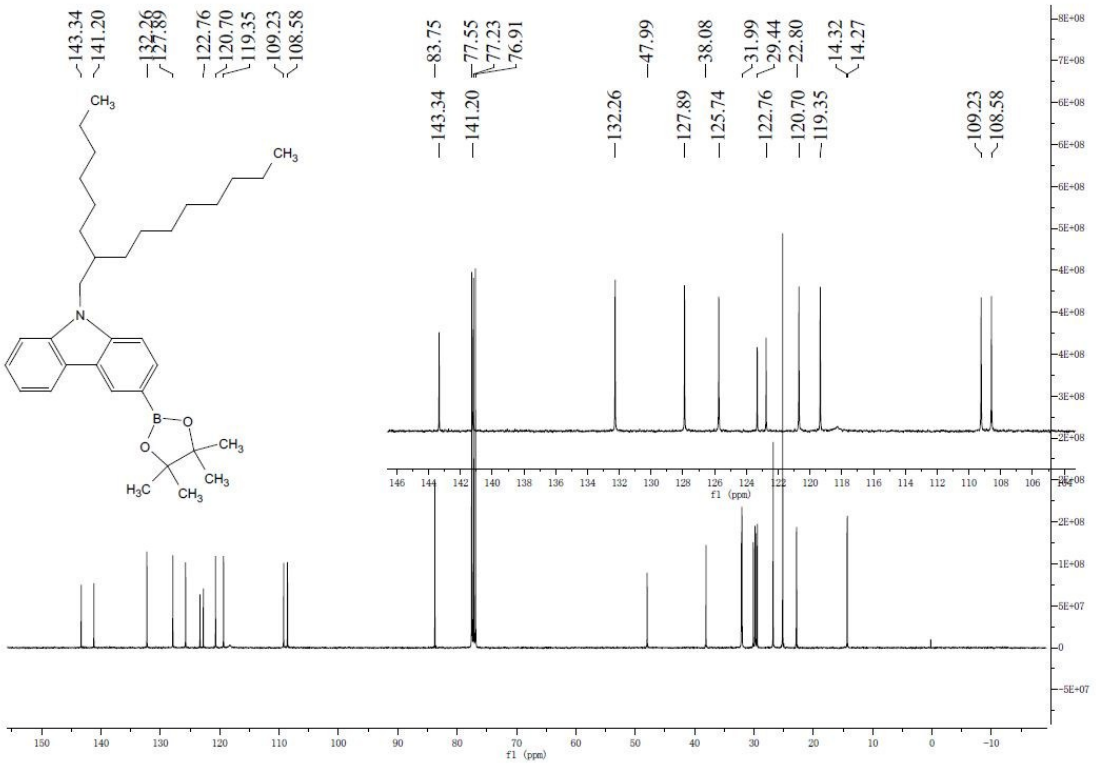


**Fig. S11** The $^{13}C$ NMR (100 MHz) of **8** in $CDCl_3$.

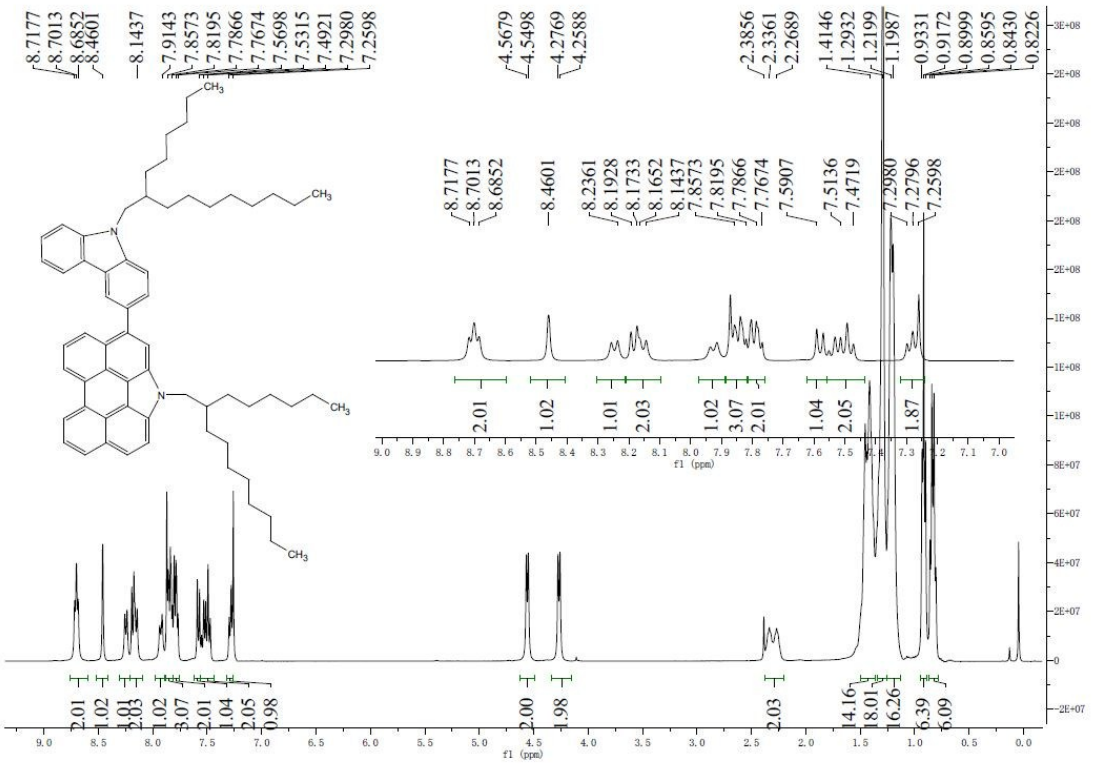

**Fig. S12** The $^{1}H$ NMR (400 MHz) of **2** in $CDCl_3$.

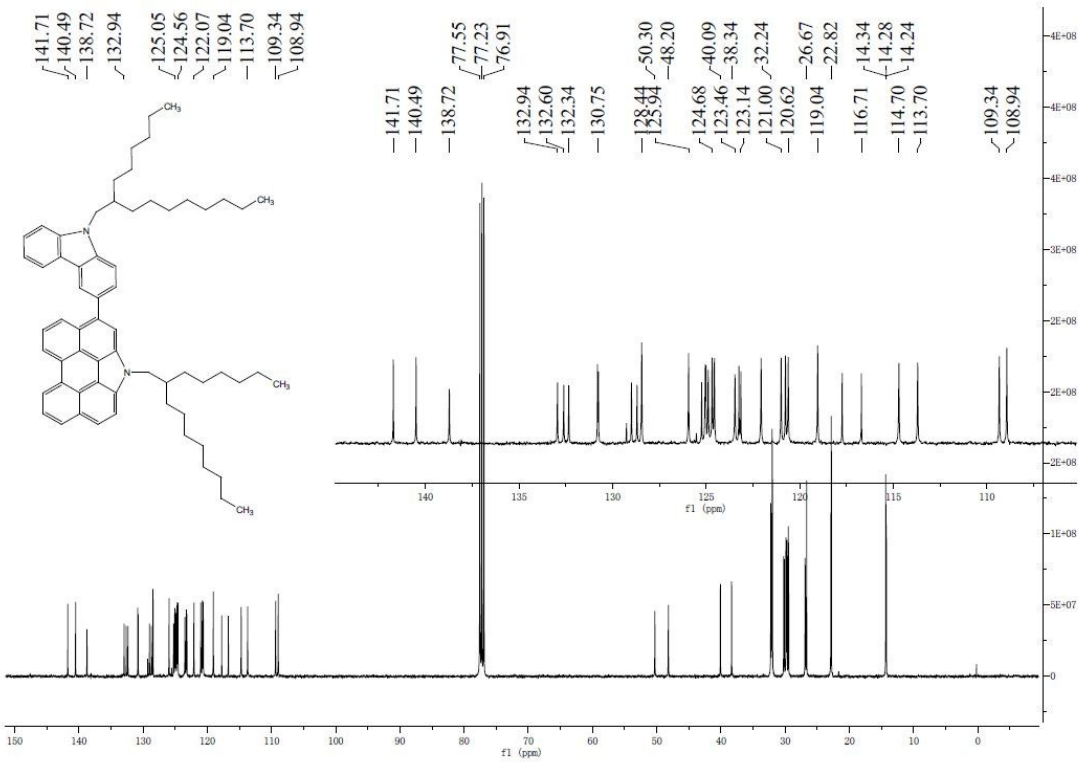


**Fig. S13** The $^{13}C$ NMR (100 MHz) of **9** in $CDCl_3$.

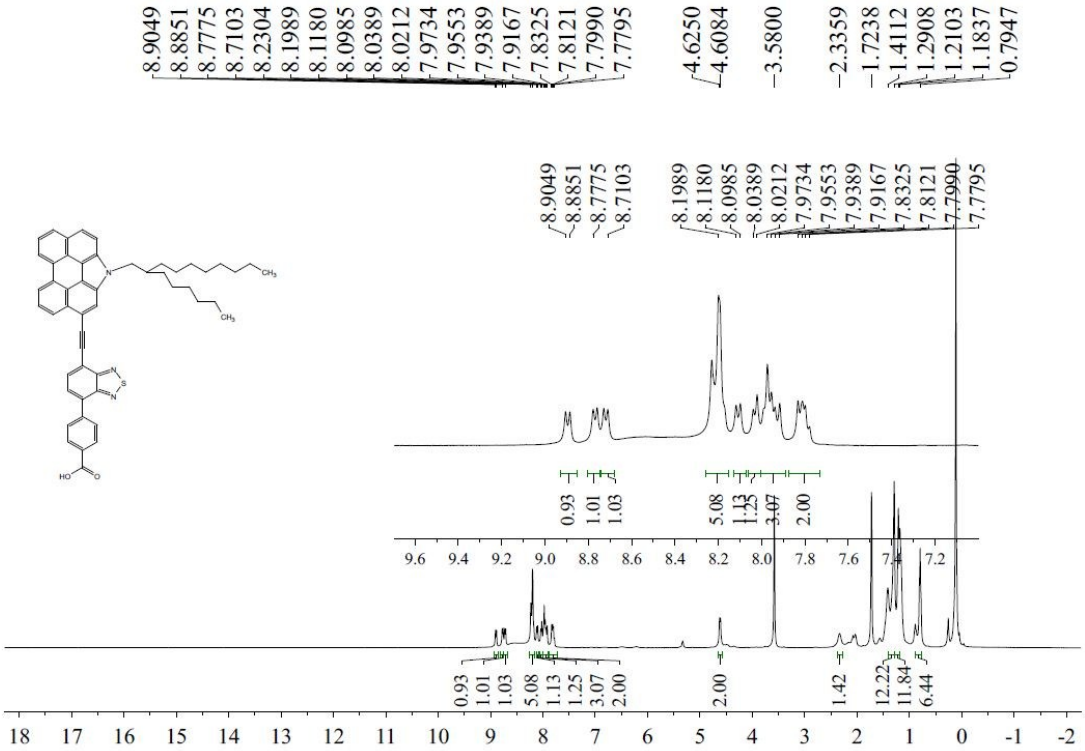


**Fig. S14** The $^{1}$H NMR (400 MHz) of **HW-1** in THF.

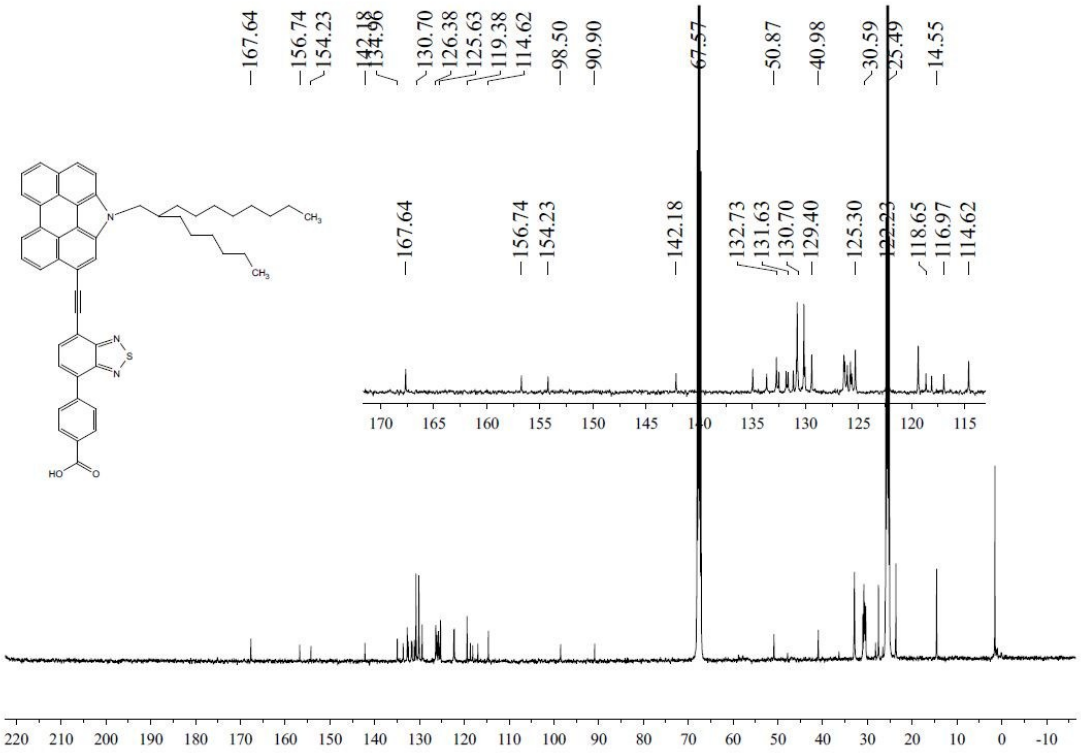


**Fig. S15** The $^{13}C$ NMR (100 MHz) of **HW-1** in THF.

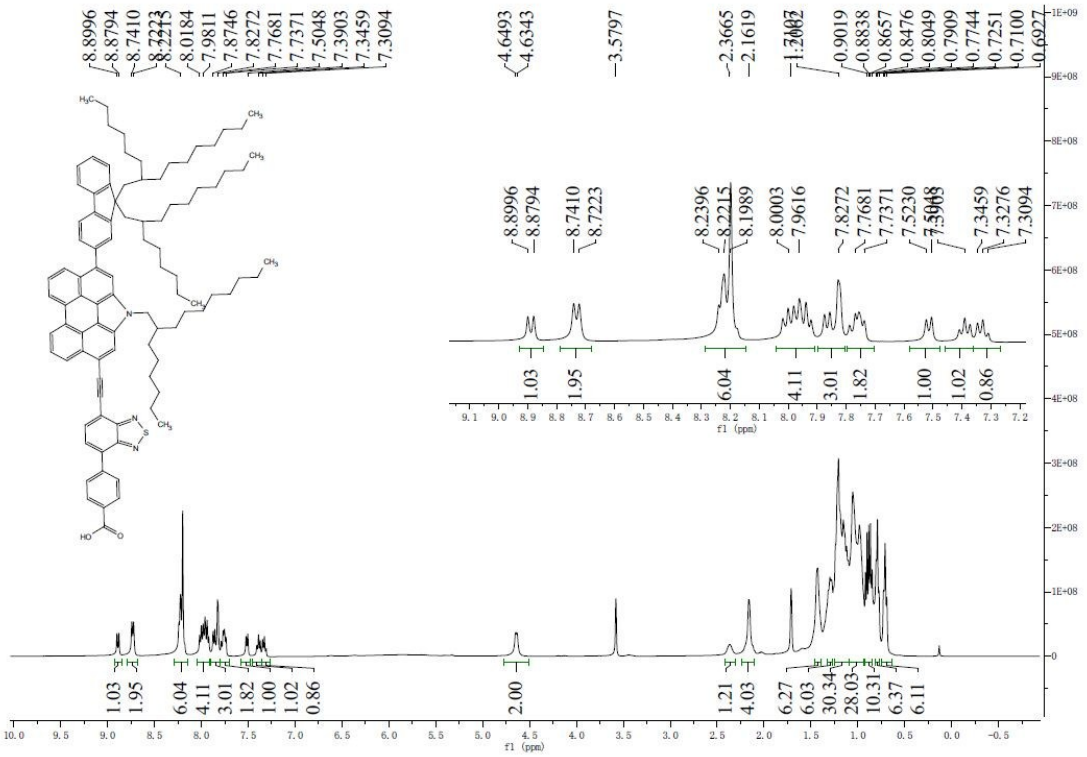

**Fig. S16** The $^{1}$H NMR (400 MHz) of **HW-2** in THF.

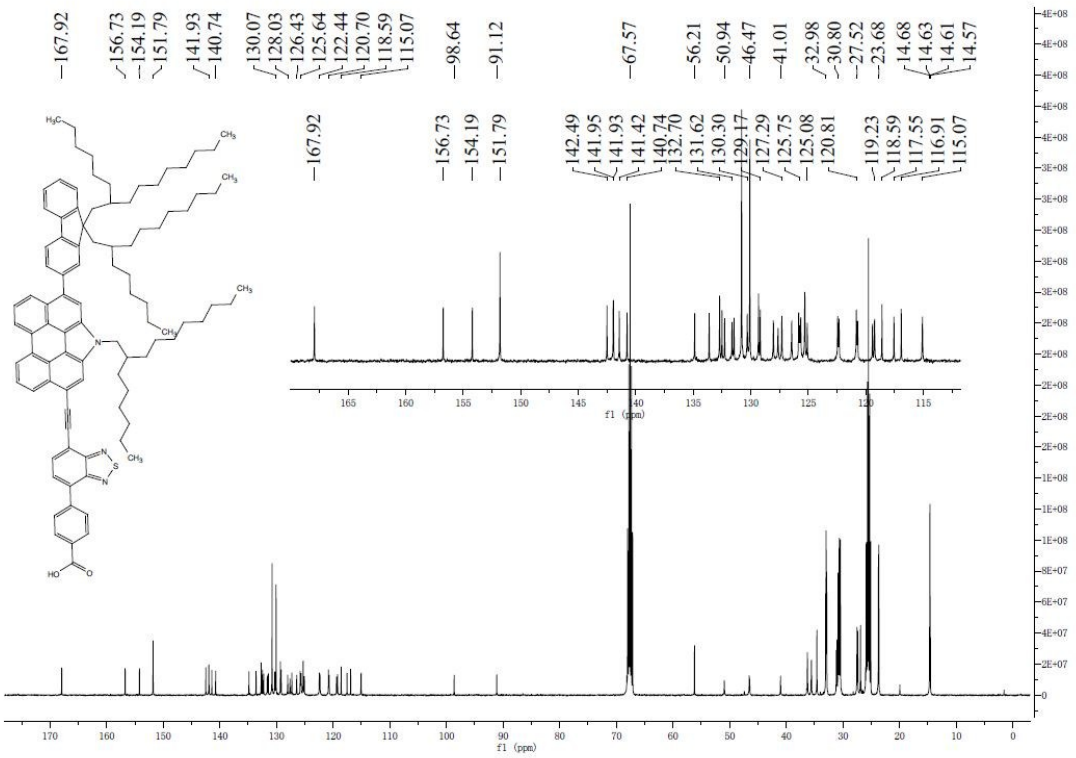


**Fig. S17** The $^{13}C$ NMR (100 MHz) of **HW-2** in THF.

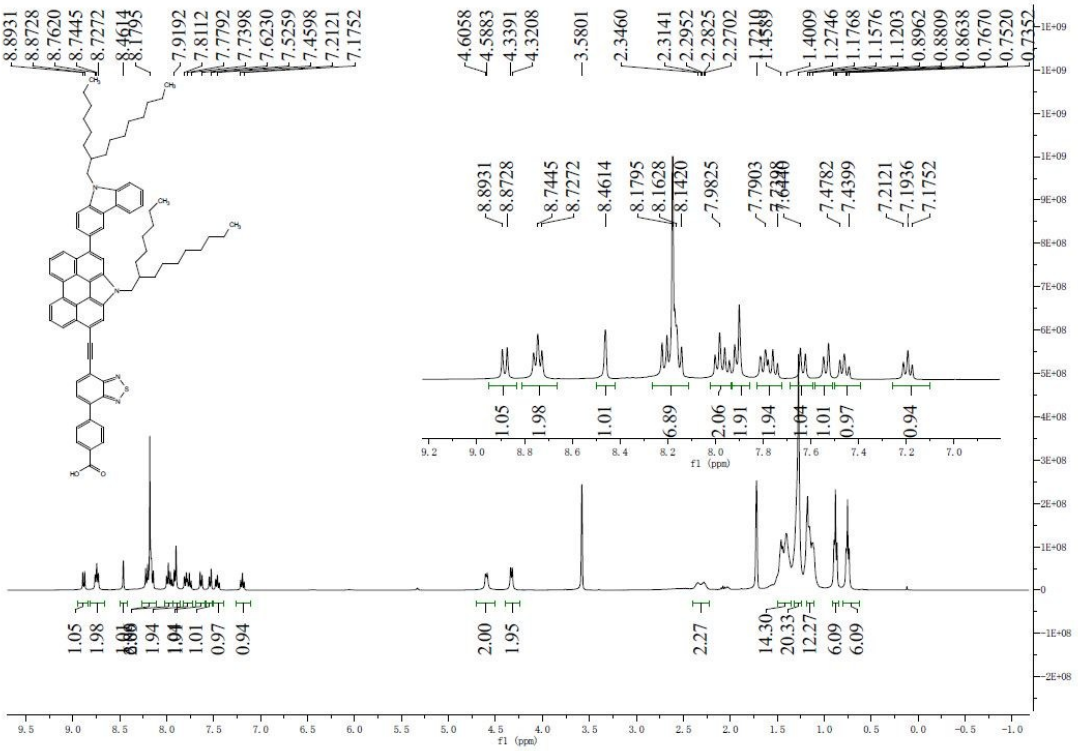

**Fig. S18** The $^{1}$H NMR (400 MHz) of **HW-3** in THF.

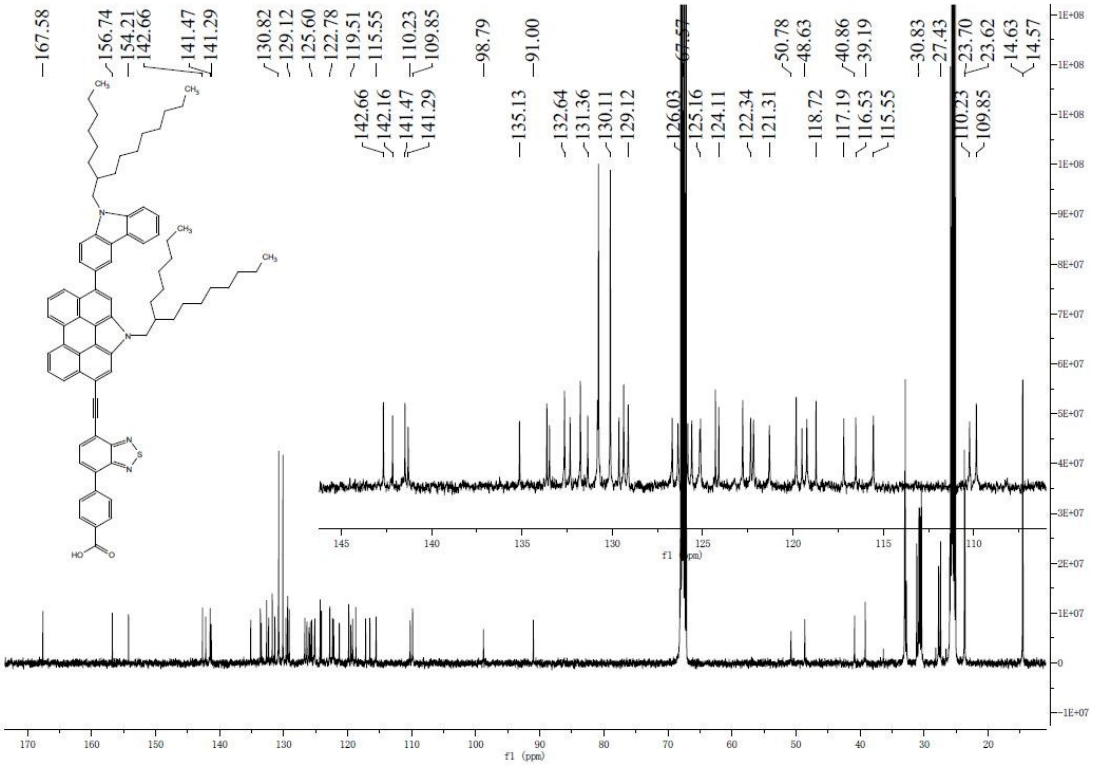


**Fig. S19** The $^{13}C$ NMR (100 MHz) of **HW-3** in THF.