

Molecular imprinting of benzylpiperazine: a comparison of the self-assembly and semi-covalent approaches

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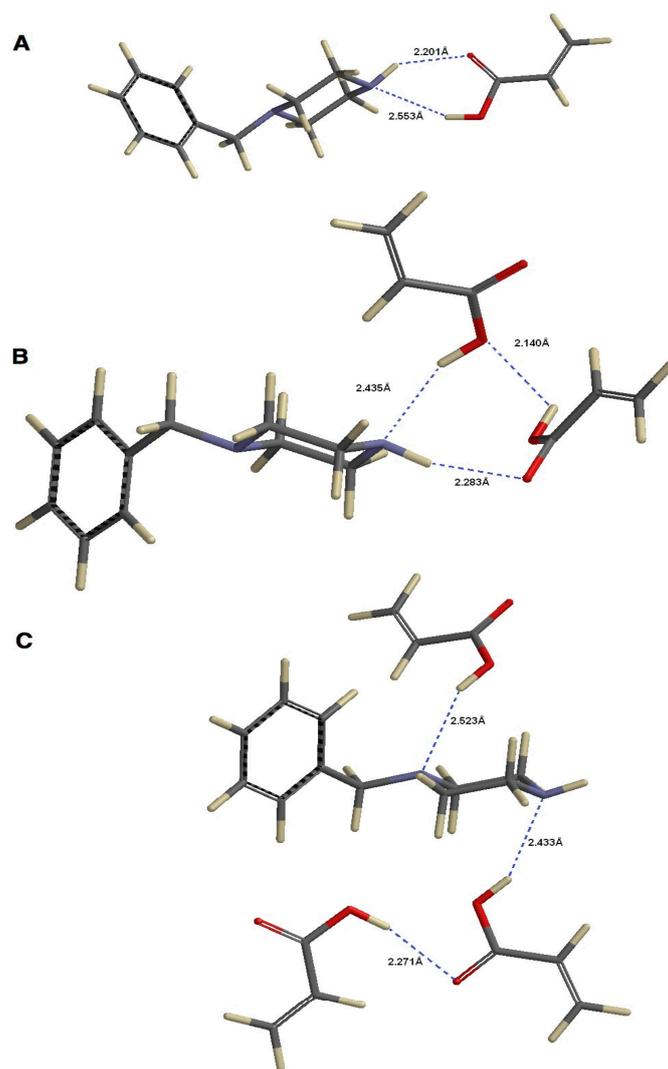


Figure S1. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with acrylic acid (**6**) in the ratios, **A**) 1:1; **B**) 1:2; and **C**) 1:3.

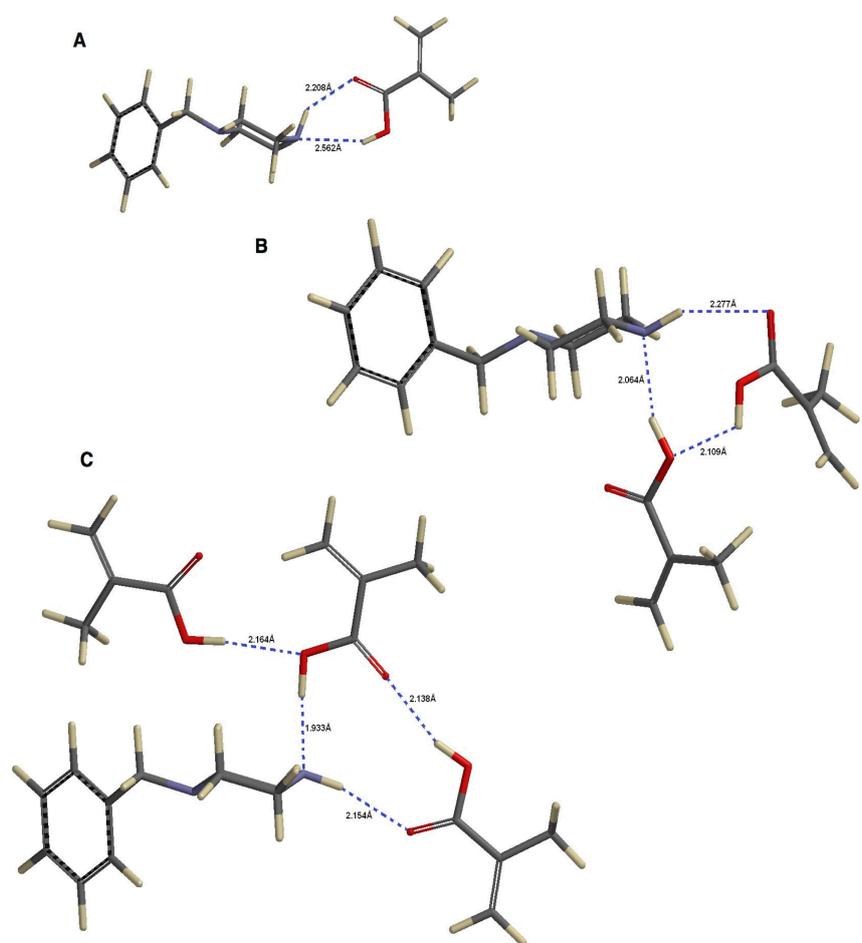


Figure S2. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with methacrylic acid (**7**) in the ratios of, **A**) 1:1; **B**) 1:2; and **C**) 1:3.

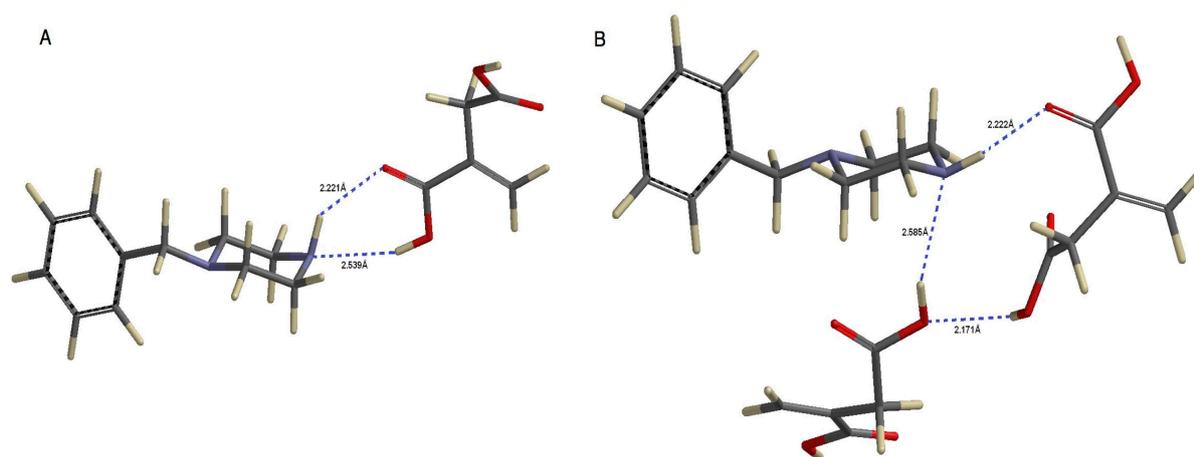


Figure S3. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with itaconic acid (**12**) in the ratios of, **A**) 1:1; and **B**) 1:2.

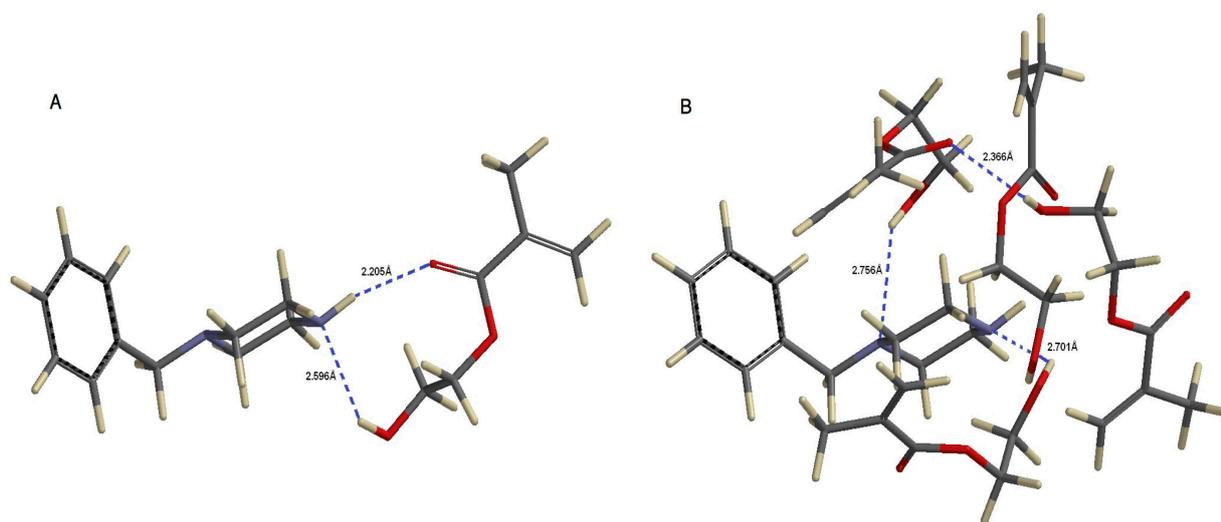


Figure S4. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with 2-hydroxymethyl methacrylate (**13**) in the ratios of, **A**) 1:1 and **B**) 1:4.

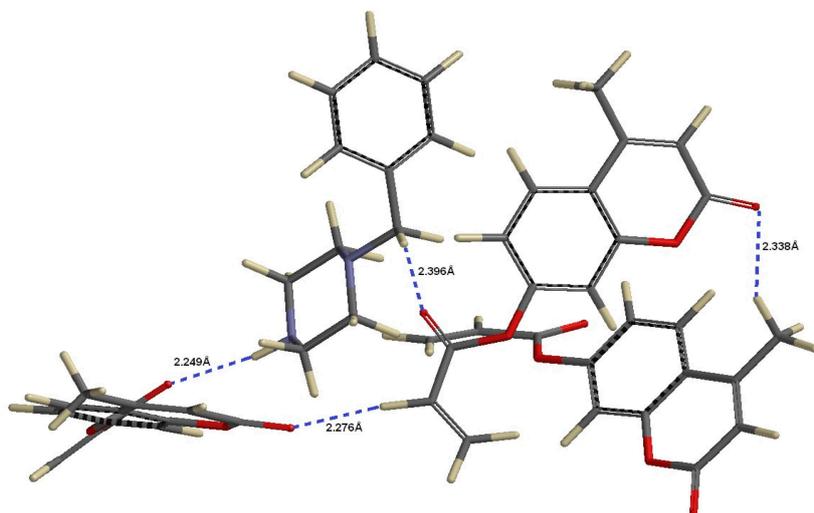


Figure S5. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with 7-hydroxy-4-methylcoumarin acrylate (**15**) in the ratio of 1:3.

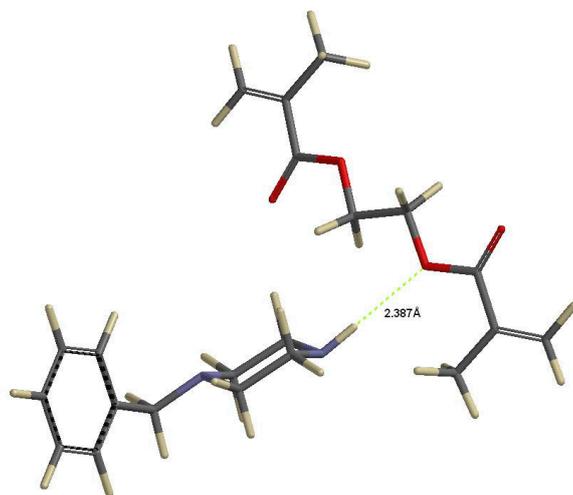


Figure S6. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with EGDMA in an optimised 1:1 ratio.

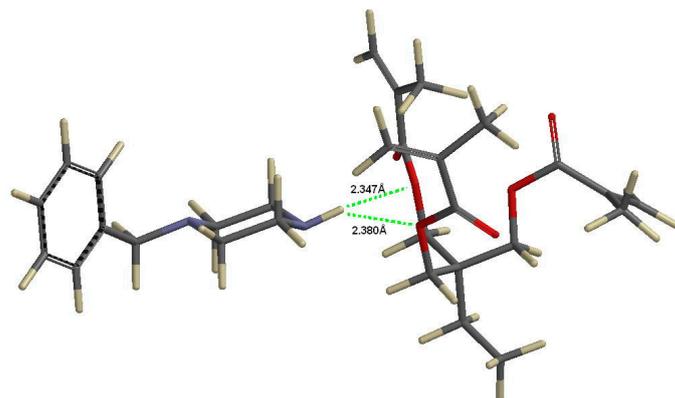


Figure S7. Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with TRIM in an optimised 1:1 ratio.

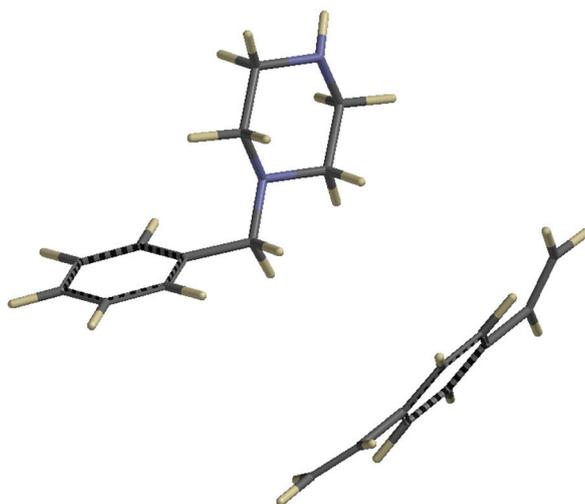


Figure S8. Computer generated molecular modelling image for benzylpiperazine (**1**) with divinylbenzene (DVB) for the geometry optimised 1:1 cluster.

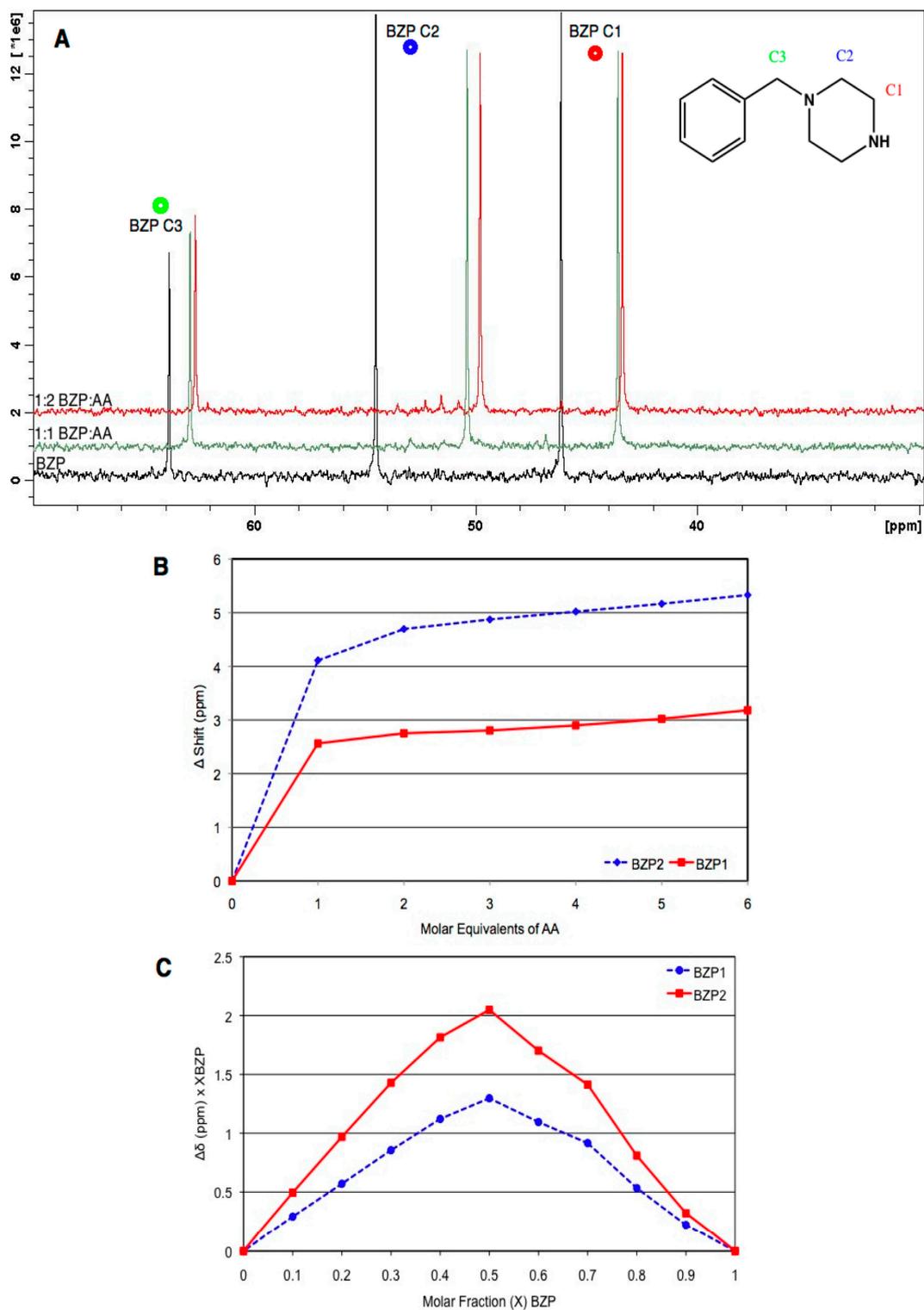


Figure S9. NMR analysis of benzylpiperazine (**BZP**, **1**) with acrylic acid (**AA**, **6**) showing, **A**) the ^{13}C NMR spectra for the NMR titration of **BZP** with **AA** at a T:FM ratio of 1:0, 1:1 and 1:2; **B**) the changes in chemical shift of carbons 1 and 2 on benzylpiperazine (**1**) as a function of increasing **6** concentration; and **C**) Job's plot of two selected **BZP** carbon resonances (C1 and C2) in the presence of **AA**. Cluster stoichiometry is 1:1. ^{13}C NMR spectra obtained at 28 °C in deuterated chloroform.

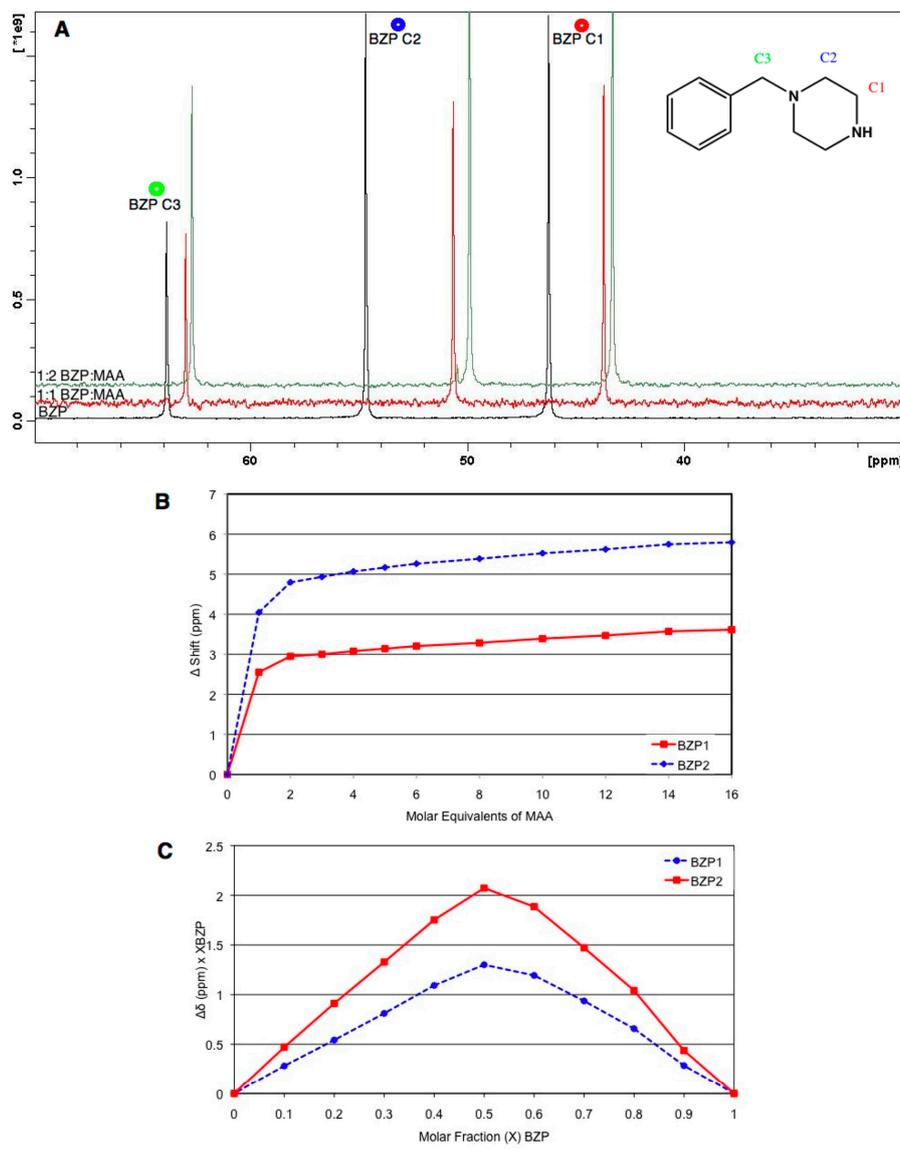


Figure S10. NMR analysis of benzylpiperazine (**BZP**, **1**) with methacrylic acids (**MMA**, **7**) showing, **A**) the ^{13}C NMR spectra for the NMR titration of **BZP** (**1**) with **MAA** (**7**) at a T:FM ratio of 1:0 (no **7** added), 1:1 and 1:2; **B**) the changes in chemical shift of **BZP** carbons 1 and 2 as a function of increasing **MAA** (**7**) concentration; and **C**) Job's plot of two selected **BZP** carbon s (C1 and C2) in the presence of **MAA** showing the predominant cluster stoichiometry as 1:1. ^{13}C NMR spectra obtained at 28 °C in deuterated chloroform.

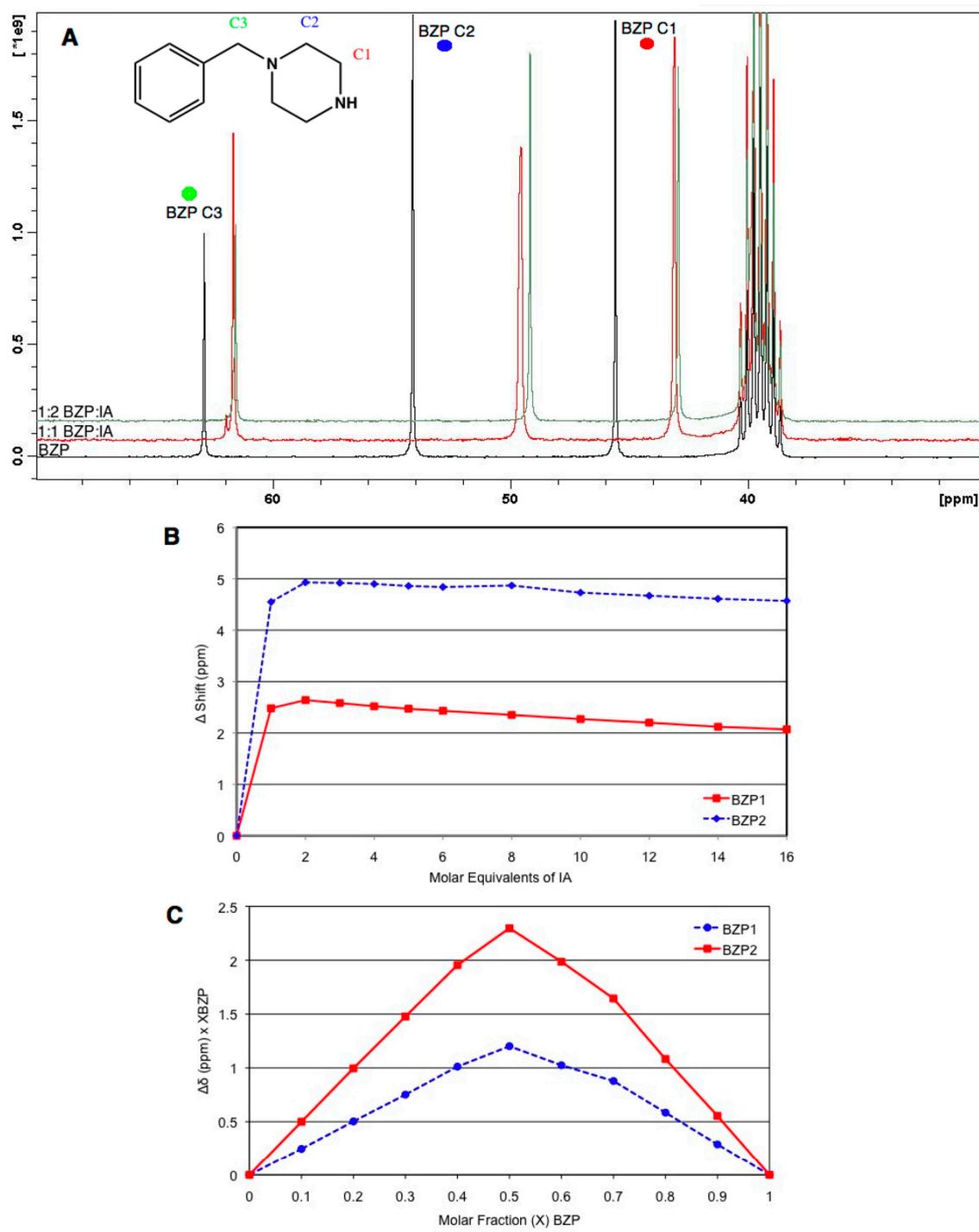


Figure S11. NMR analysis of benzylpiperazine (**BZP**, **1**) with itaconic acid (**IA**, **12**) showing, **A**) the ^{13}C NMR spectra for the NMR titration of **BZP** (**1**) with **IA** at a T:FM ratio of 1:0, 1:1 and 1:2 **BZP** (**1**):**IA**; **B**) the changes in chemical shift of carbons 1 and 2 on **BZP** as a function of increasing **IA** concentration; and **C**) Job's plot of two selected **BZP** carbon resonances (C1 and C2) in the presence of **IA**. Cluster stoichiometry is 1:1. ^{13}C NMR spectra obtained at 28 °C in deuterated DMSO.

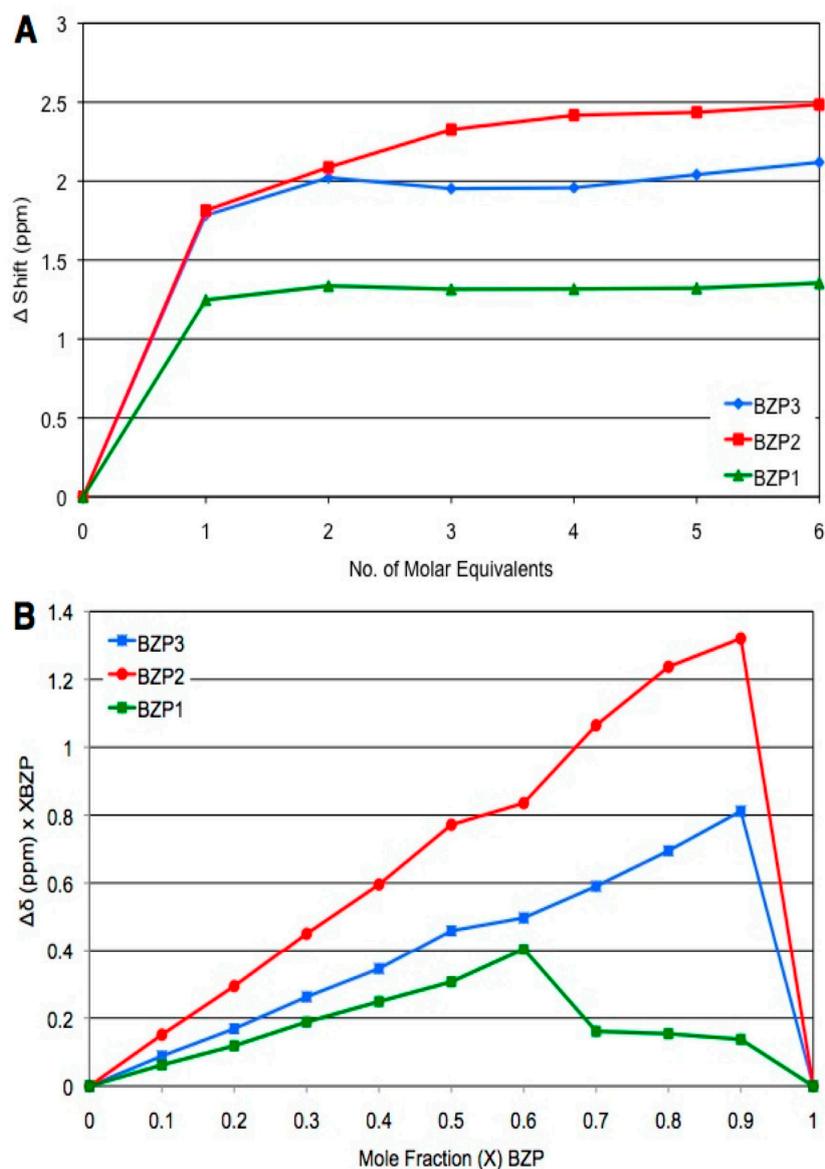


Figure S12. NMR analysis of benzylpiperazine (**BZP**, **1**) with 7-hydroxy-4-methylcoumarin acrylate (**HMCA**, **15**) showing, **A**) the changes in chemical shift of carbons 1 and 2 on **BZP** as a function of increasing **HMCA** concentration; and **B**) Job's plot of two selected benzylpiperazine (**1**) carbon resonances (C1 and C2) in the presence of **HMCA**. Cluster stoichiometry was 9:1 **BZP**:**HMCA**. ^{13}C NMR spectra obtained at 28 °C in deuterated chloroform.

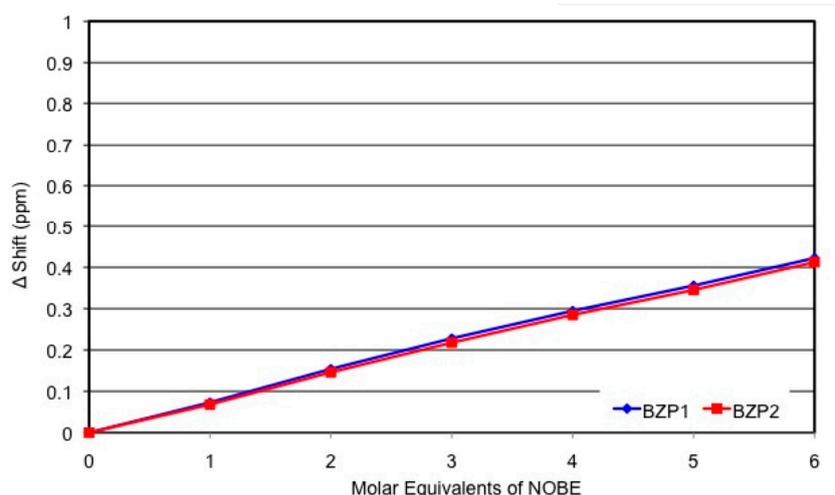


Figure S13. NMR titration of benzylpiperazine (**BZP**, **1**) with N,O-bismethacroyloyl ethanolamine (**NOBE**, **14**) showing the changes in chemical shift of carbons 1 and 2 on **BZP** as a function of increasing **NOBE** concentration.

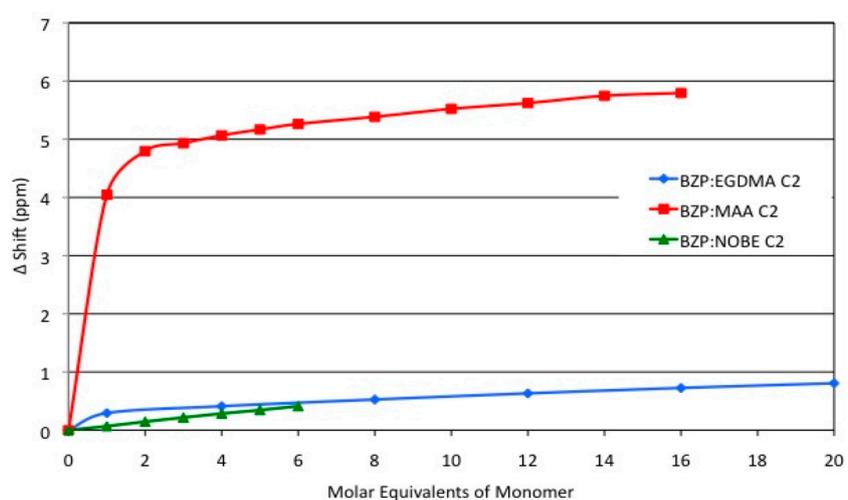


Figure S14. NMR titration of benzylpiperazine (**BZP**, **1**) with N,O-bismethacroyloyl ethanolamine (**NOBE**, **14**), methacrylic acid (**MAA**, **7**) and ethylene glycol dimethylacrylate (**EGDMA**) showing the changes in chemical shift of carbon 1 on **BZP** as a function of increasing monomer concentration.

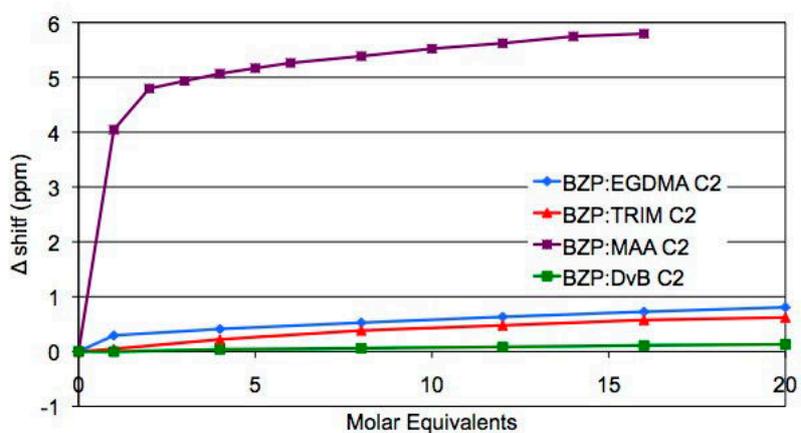


Figure S15. NMR titration of benzylpiperazine (**BZP**, **1**) with ethylene glycol dimethylacrylate (**EGDMA**), trimethylolpropane trimethylacrylate (**TRIM**), divinylbenzene (**DVB**) and methacrylic acid (**MAA**, **7**) showing the most significant change in chemical shift experienced as a function of increasing **EGDMA**, **TRIM**, **DVB** and **MAA** concentration, respectively. **MAA** has been included for comparison

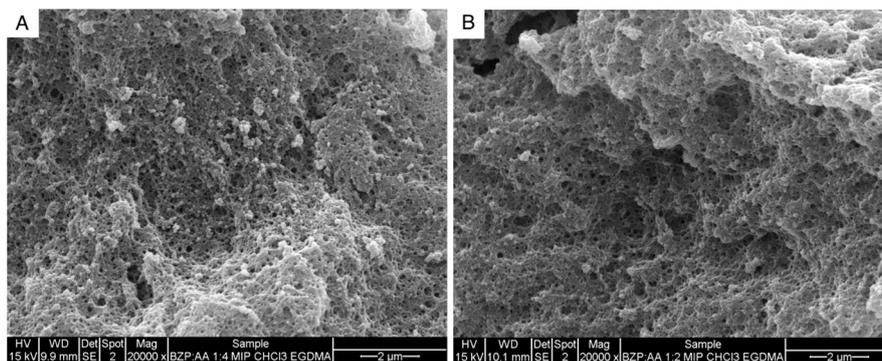


Figure S16. SEM images for A) E6₄-MIP_{CHCl3} and B) E6₂-MIP_{CHCl3} MIPs obtained at 20000x magnification at 15.0 kV.

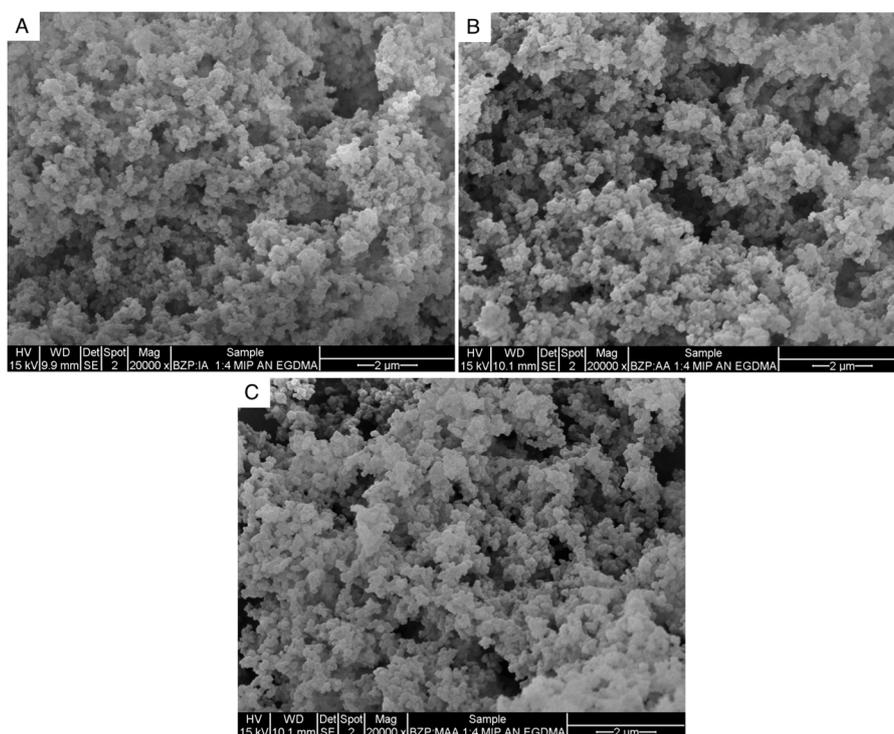


Figure S17. SEM images for A) E12₄-MIP_{CH3CN}, B) E6₄-MIP_{CH3CN} and C) E7₄-MIP_{CH3CN} MIPs obtained at 20000x magnification at 15.0 kV.

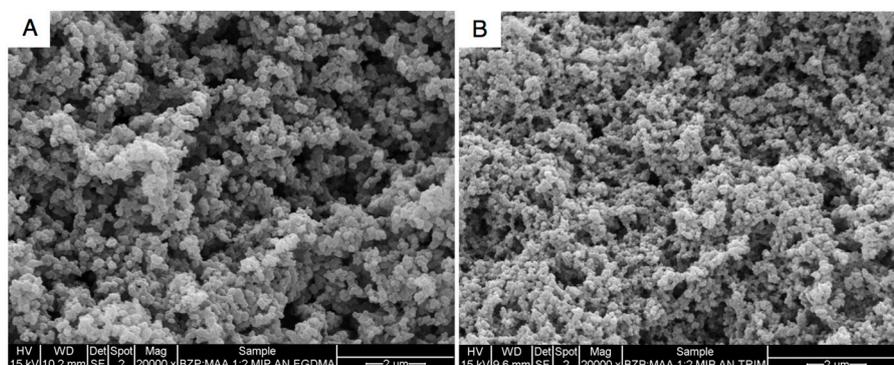


Figure S18. SEM images for A) E7₂-MIP_{CH3CN}, and B) T7₂-MIP_{CH3CN} MIPs obtained at 20000x magnification at 15.0 kV.

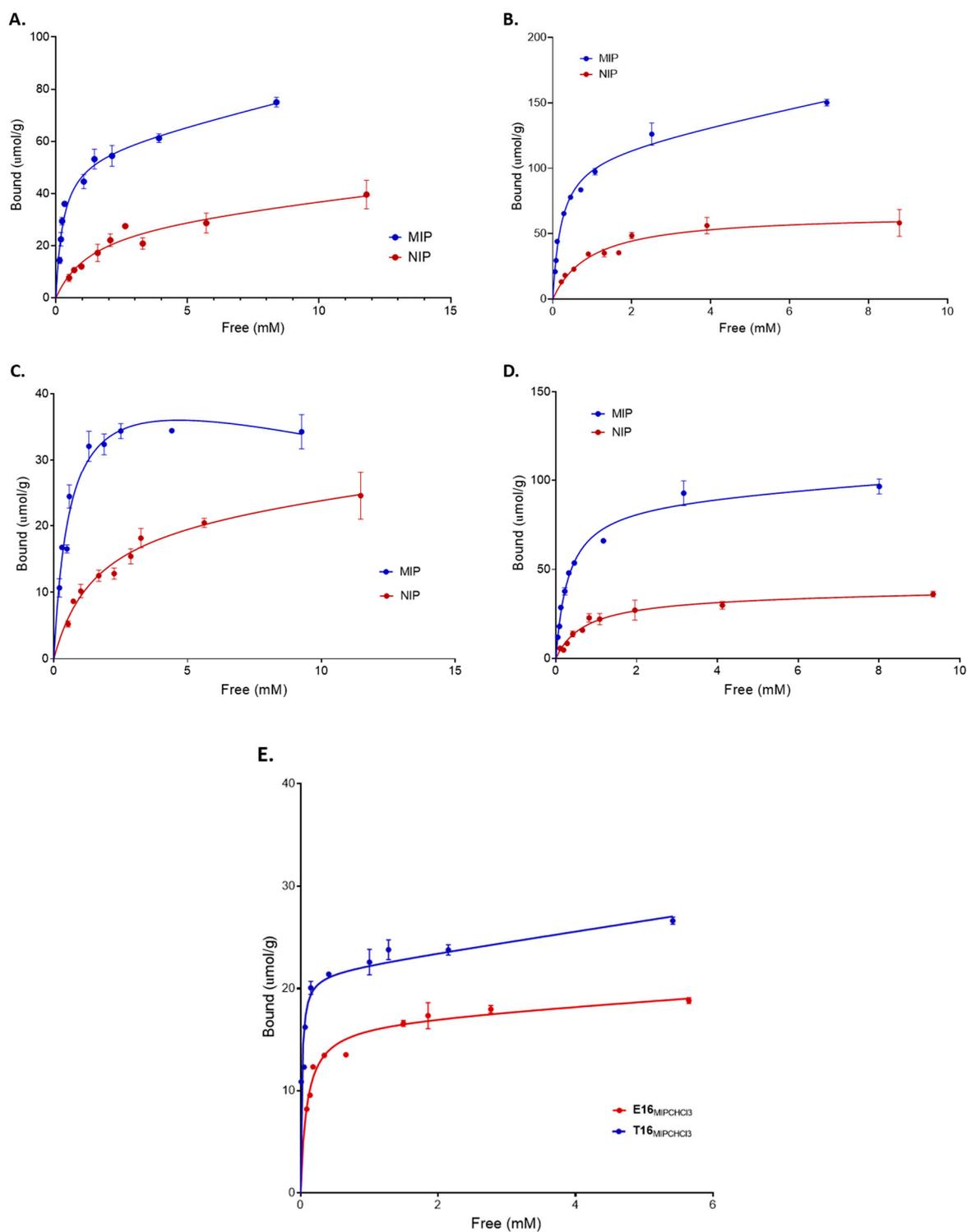


Figure S19. Binding isotherms produced for (A) E7₁-MIPCHC13; (B) E7₂-MIPCHC13; (C) T7₁-MIPCHC13; and (D) T7₂-MIPCHC13 and (E) semi-covalent E16_{MIPCHC13} and T16_{MIPCHC13} .

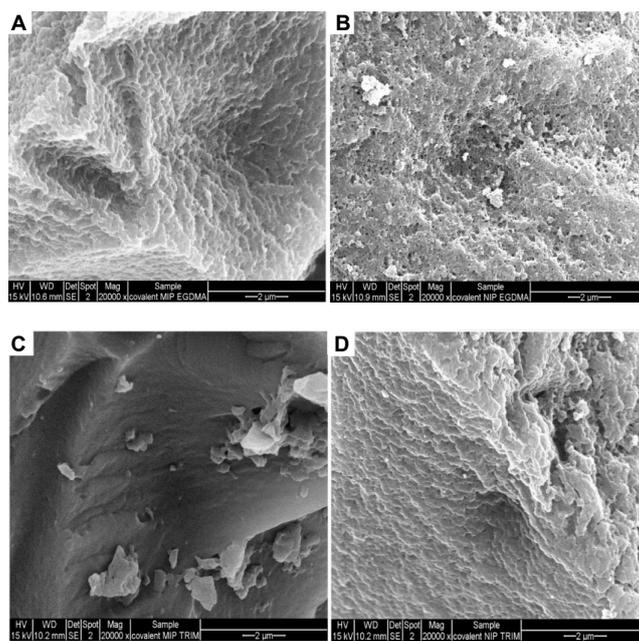


Figure S20. SEM images for (A) E16_{MIPCHCl3}, (B) E_{NIP}, (C) T16_{MIPCHCl3} and (D) T_{NIP}.

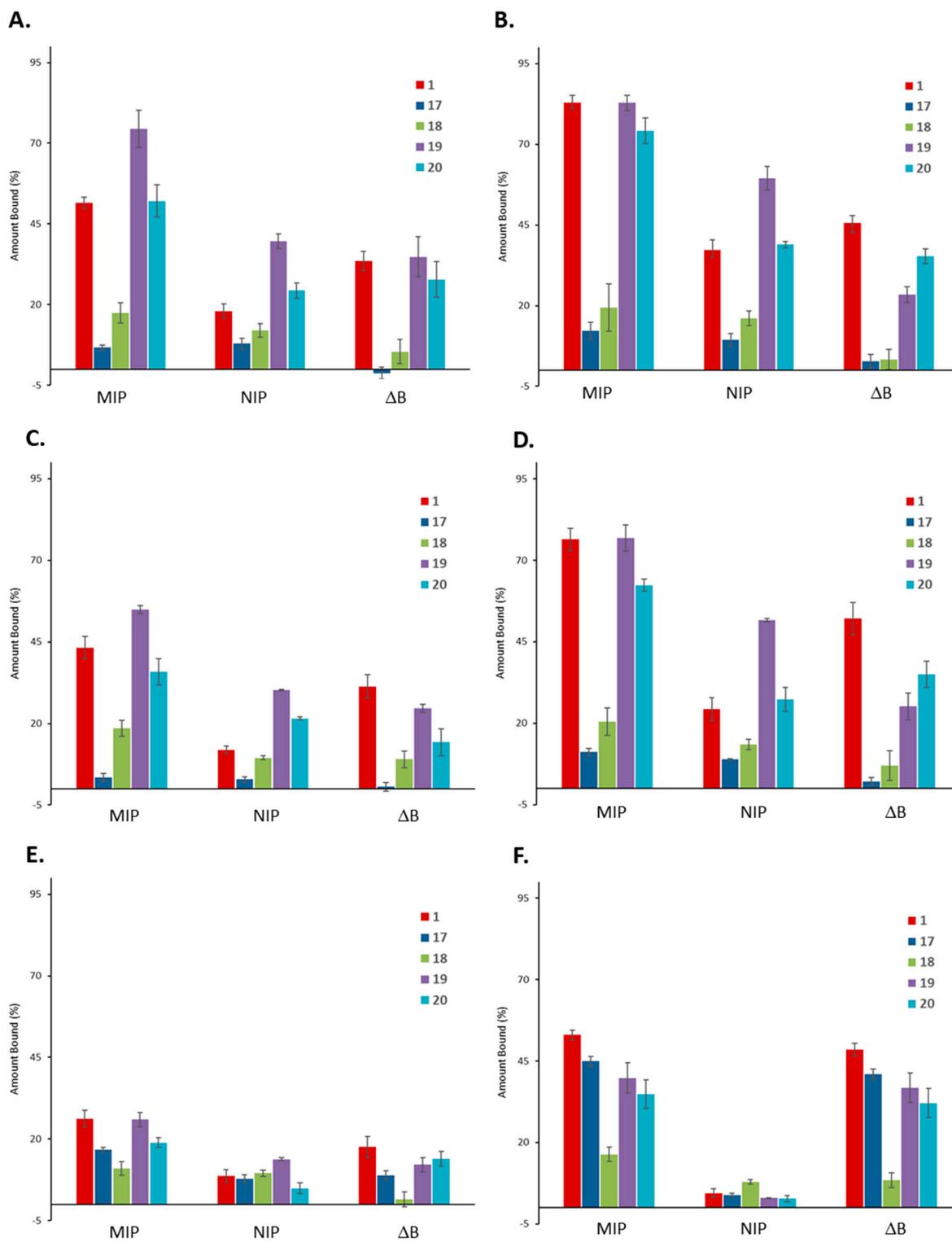


Figure S21. Cross-reactivity data for (A) $E7_{1-MIPCHCl_3}$; (B) $E7_{2-MIPCHCl_3}$; (C) $T7_{1-MIPCHCl_3}$; (D) $T7_{2-MIPCHCl_3}$; (E) $E16_{MIPCHCl_3}$; and (F) $T16_{MIPCHCl_3}$ using 20 mg of polymer and 0.8 mM analyte solutions at $t = 60$ min in triplicate.

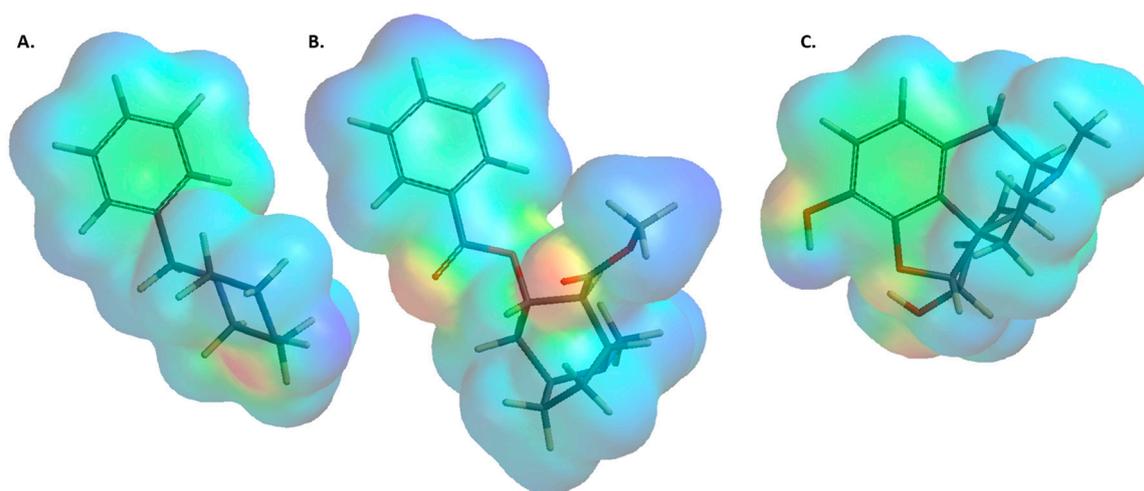


Figure S22. Molecular modelling images of **1** (A), **17** (B) and **18** (C) showing their differences in surface potential and size.

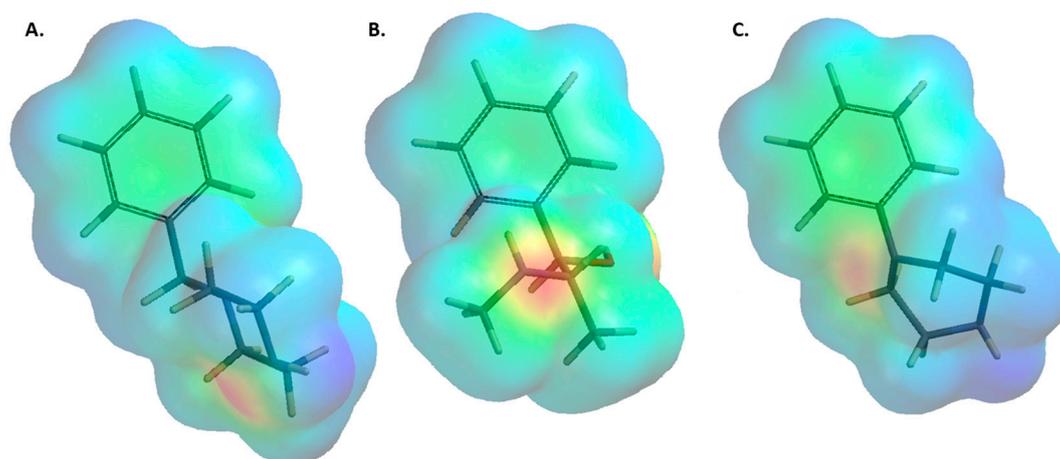


Figure S23. Molecular modelling images of **1** (A), **19** (B) and **20** (C) showing their similarities in surface potential and size.

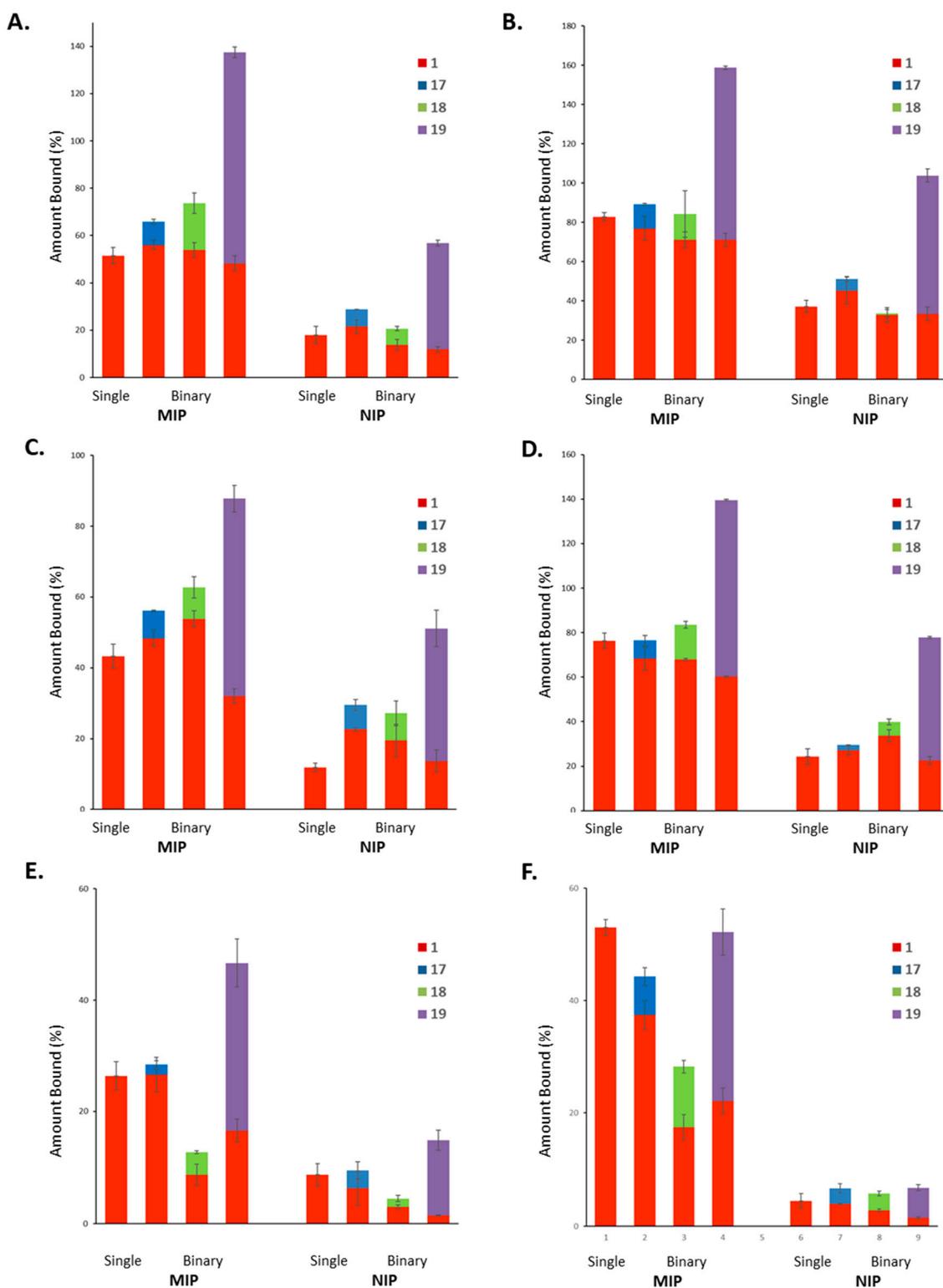


Figure S24. Competitive binary binding data for (A) E7₁-MIPCHCl₃; (B) E7₂-MIPCHCl₃; (C) T7₁-MIPCHCl₃; (D) T7₂-MIPCHCl₃; (E) E16_{MIPCHCl₃}; and (F) T16_{MIPCHCl₃} using 20 mg of polymer and a mixture of 0.8 mM solution of 1 and 0.8 mM solution of analyte (17, 18 or 19) at t = 60 min in triplicate. Binding is expressed in % with respect to the original concentration; for a binary system, this would translate to values higher than 100%.