

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

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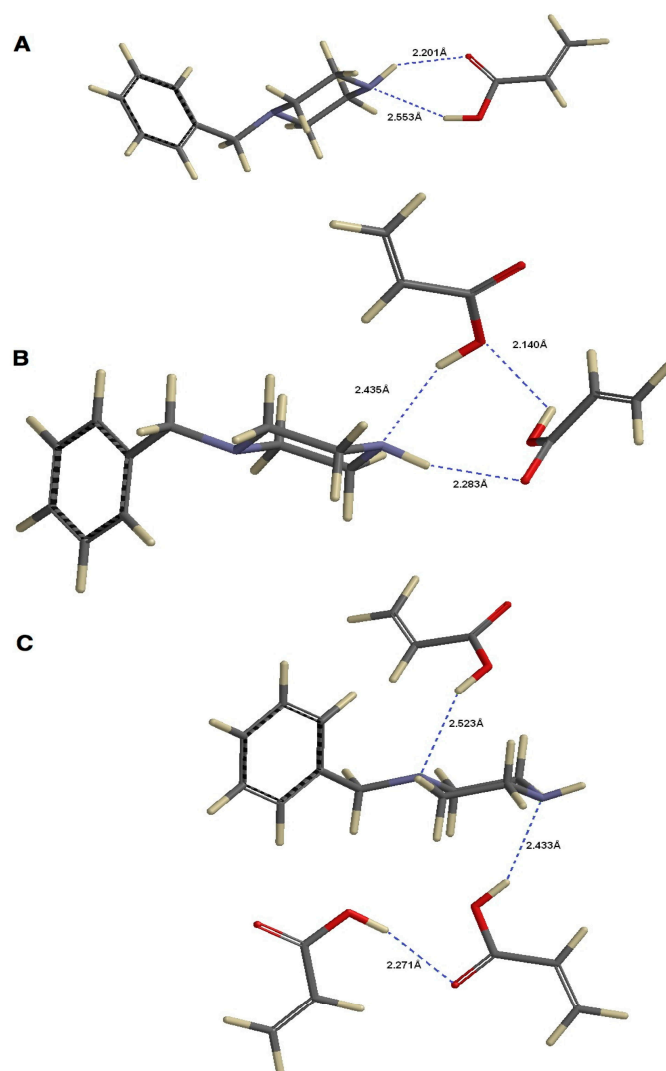
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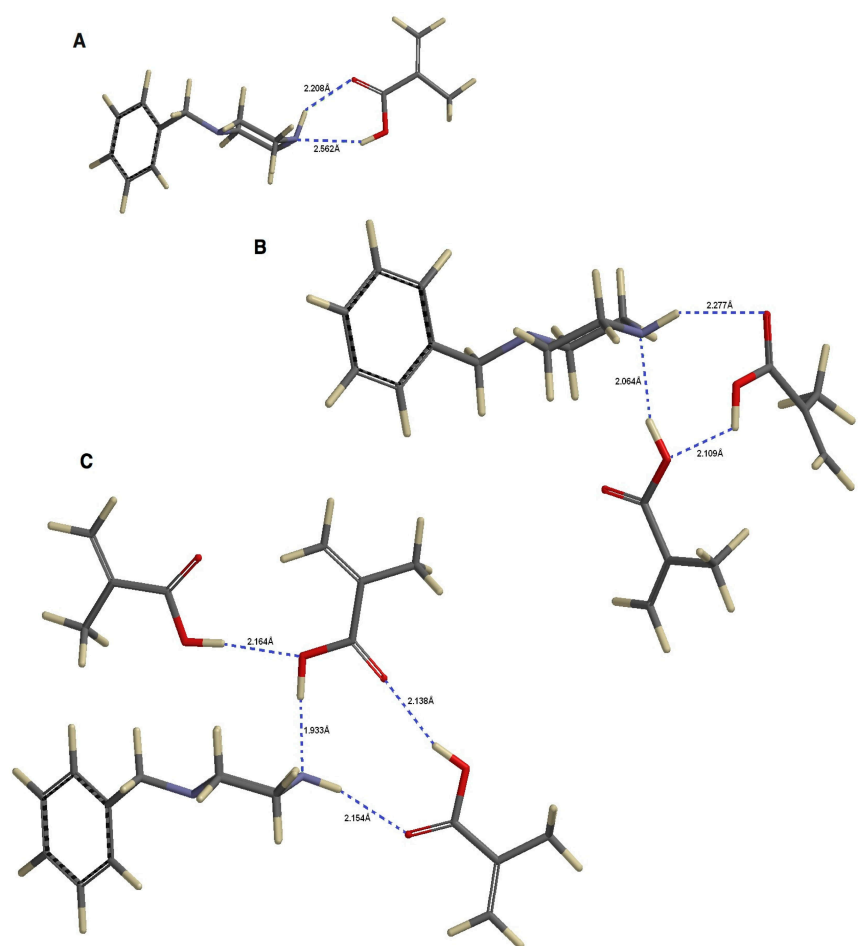
## Electronic Supporting Information

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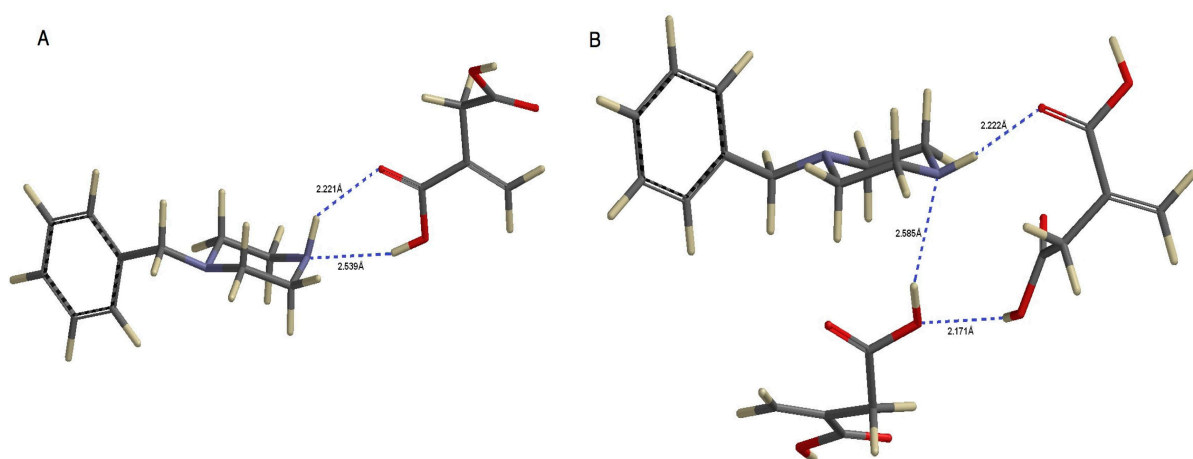
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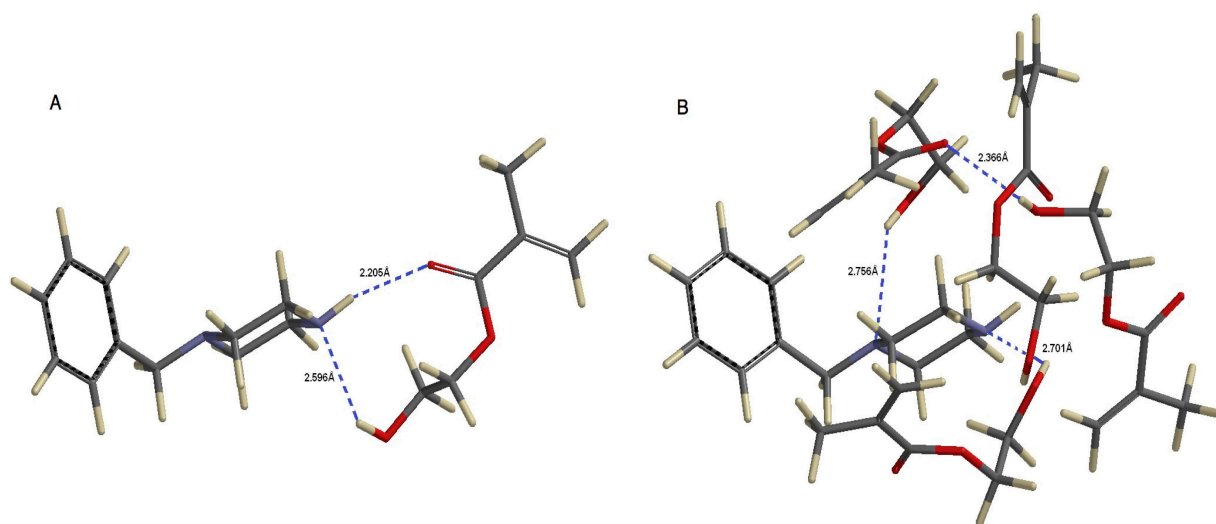
**Figure S1.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with acrylic acid (**6**) in the ratios, **A**) 1:1; **B**) 1:2; and **C**) 1:3.



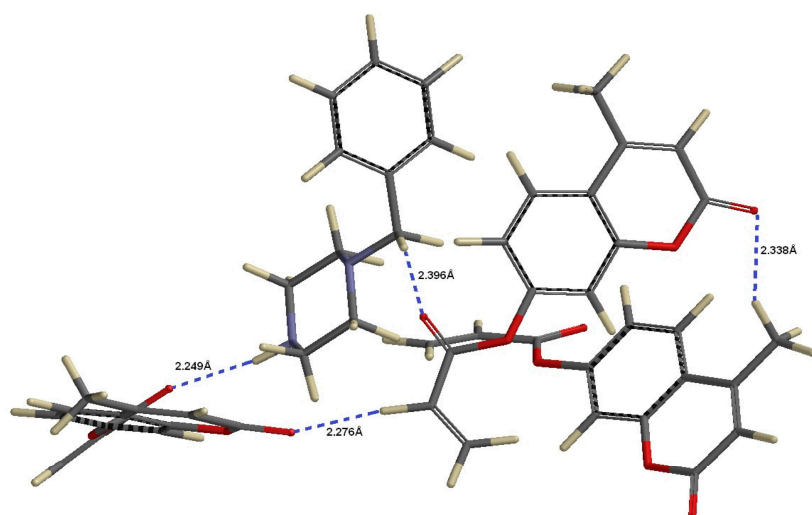
**Figure S2.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with methacrylic acid (**7**) in the ratios of, **A**) 1:1; **B**) 1:2; and **C**) 1:3.



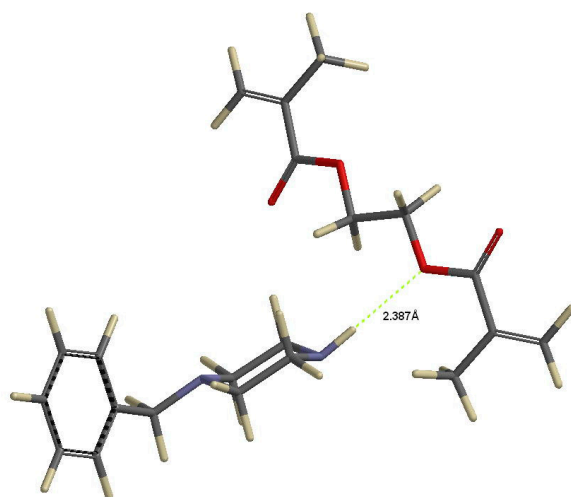
**Figure S3.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with itaconic acid (**12**) in the ratios of, **A**) 1:1; and **B**) 1:2.



**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.

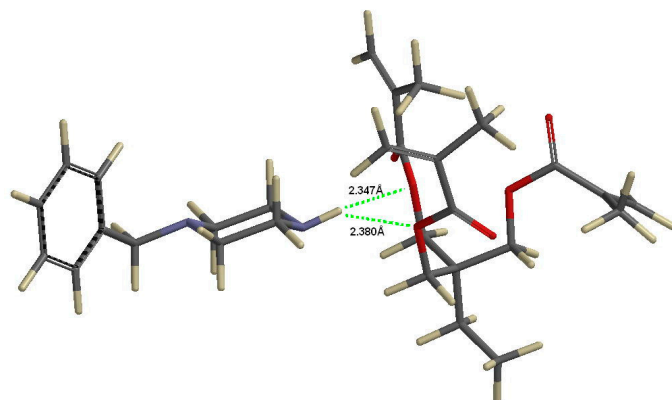


**Figure S5.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with 7-hydroxy-4-methylcoumarin acrylate (**15**) in the ratio of 1:3.

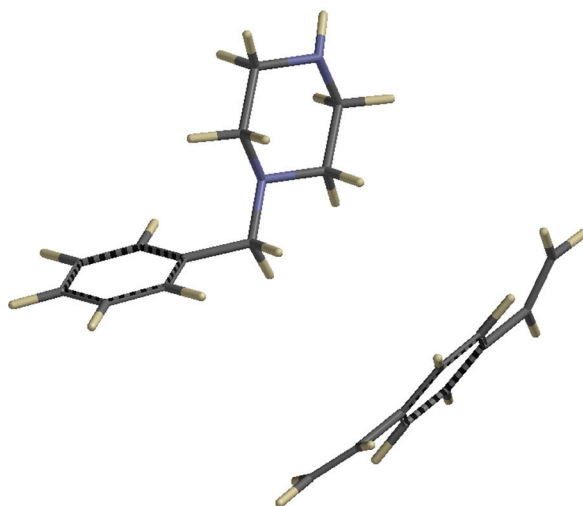


**Figure S6.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with EGDMA in an optimised 1:1 ratio.

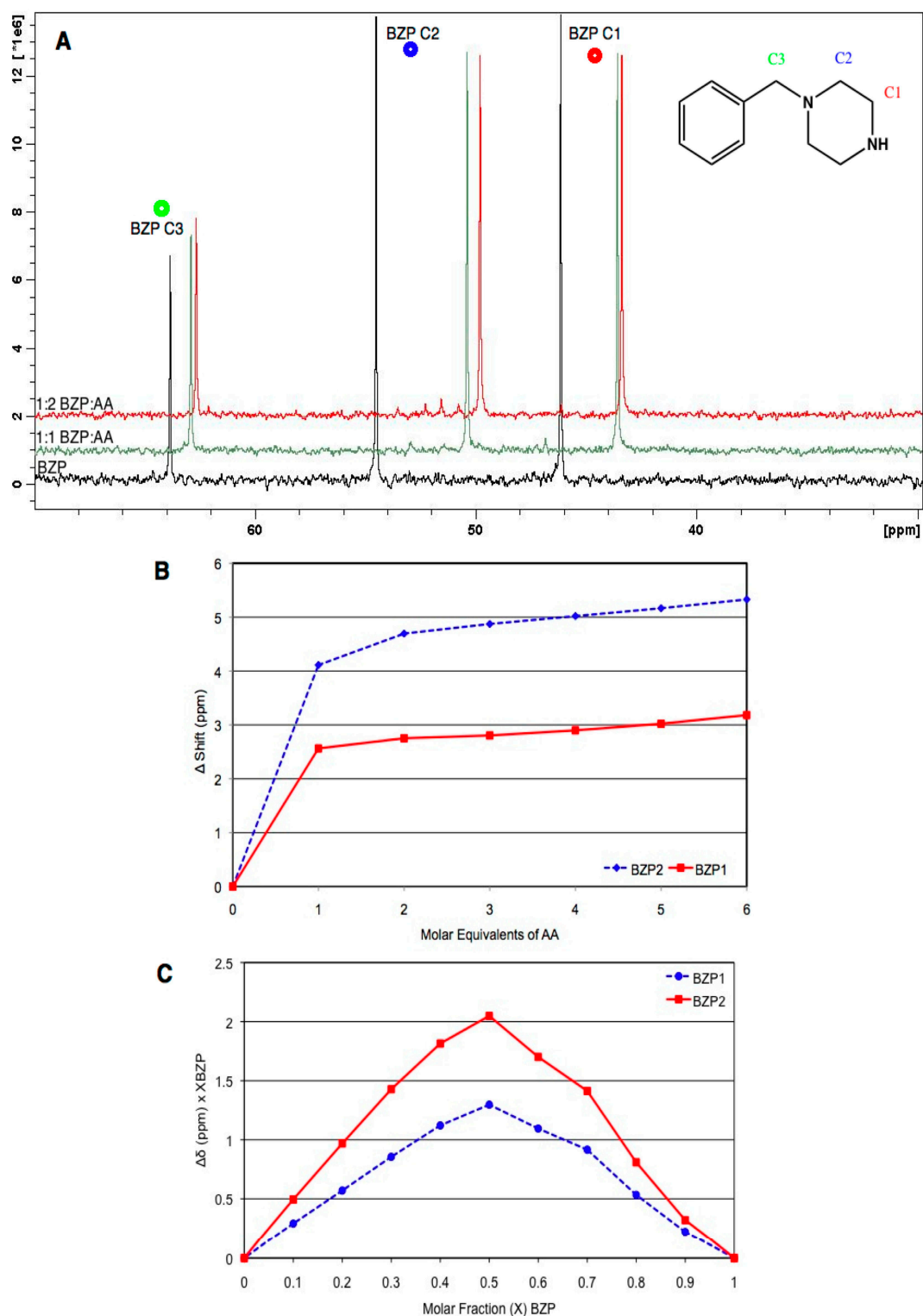




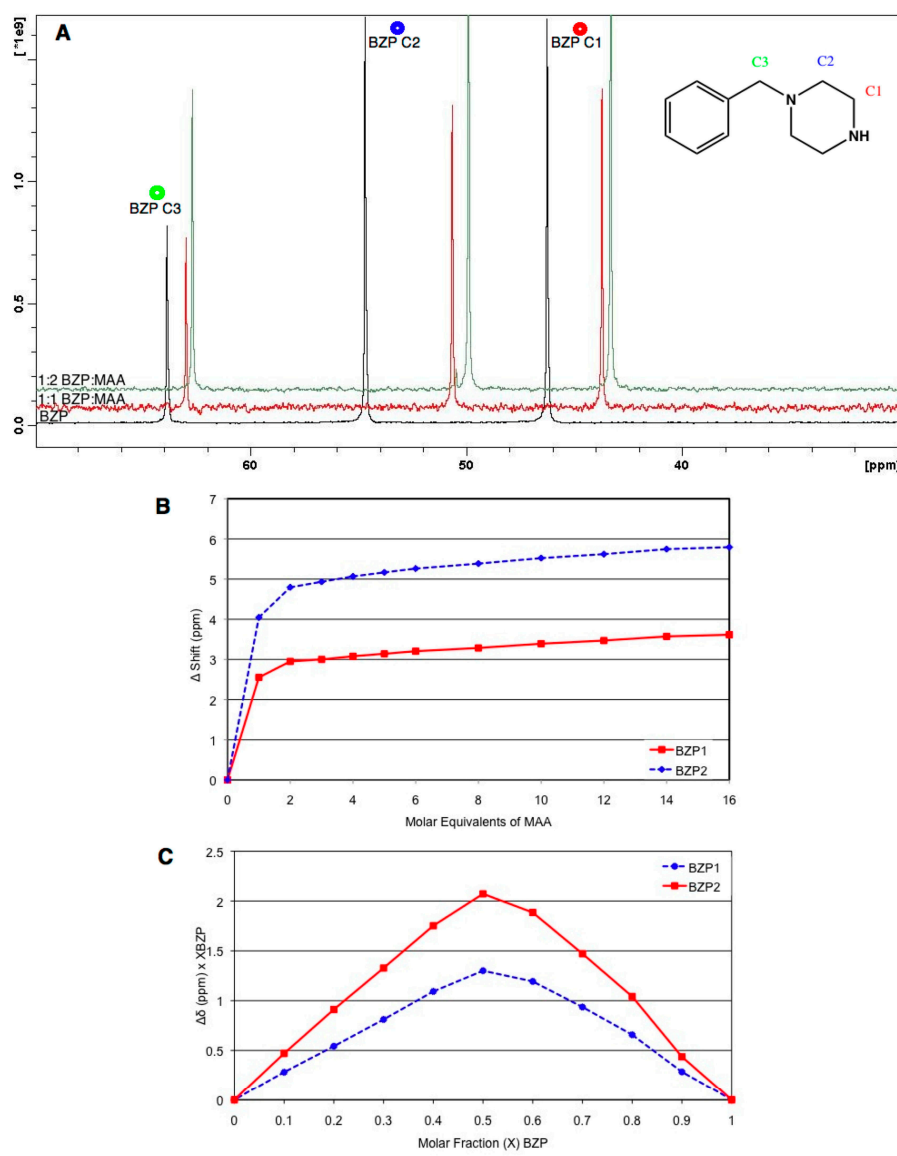
**Figure S7.** Energy minimised computer modelling representations of the interaction of benzylpiperazine (**1**) with TRIM in an optimised 1:1 ratio.



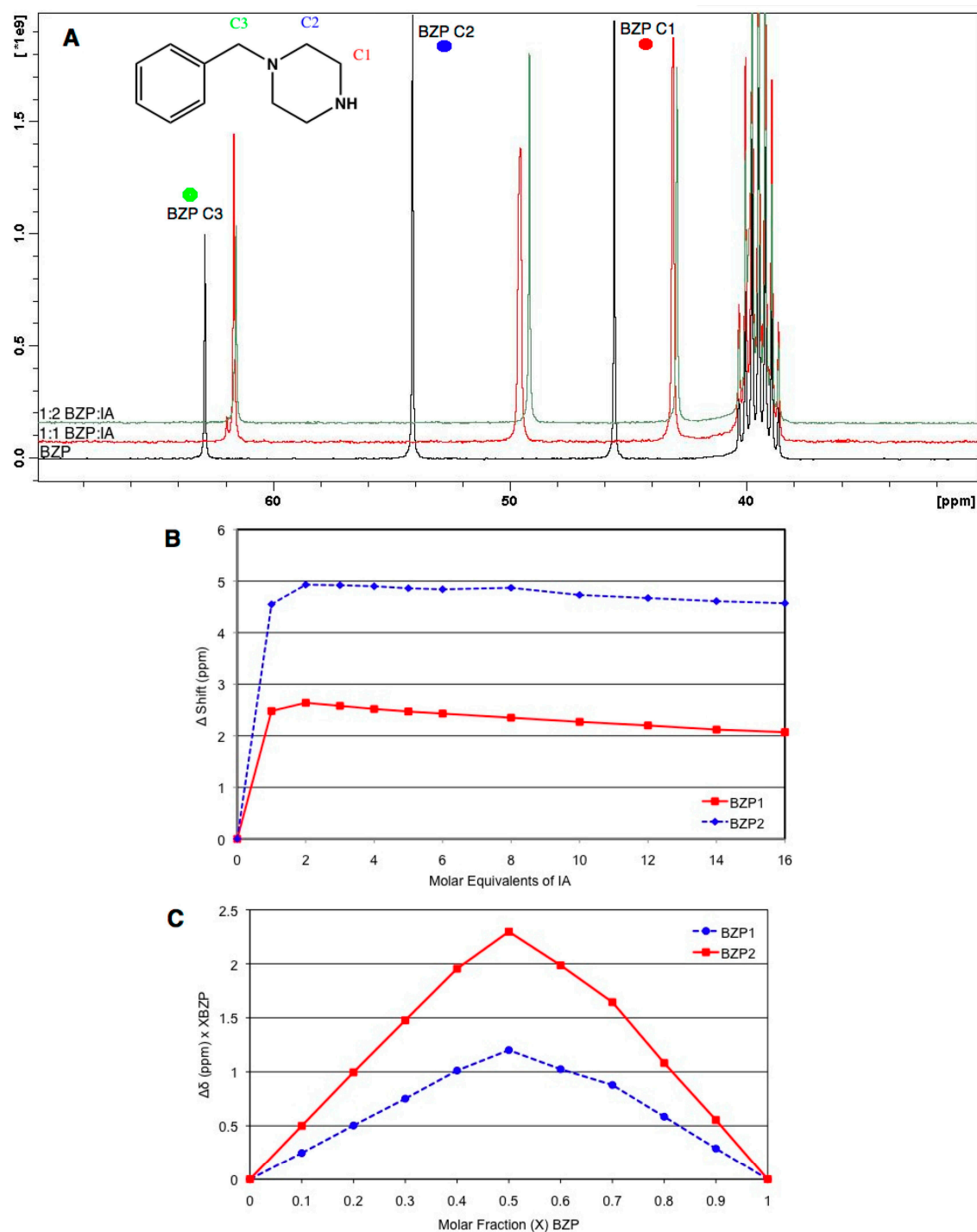
**Figure S8.** Computer generated molecular modelling image for benzylpiperazine (**1**) with divinylbenzene (DVB) for the geometry optimised 1:1 cluster.



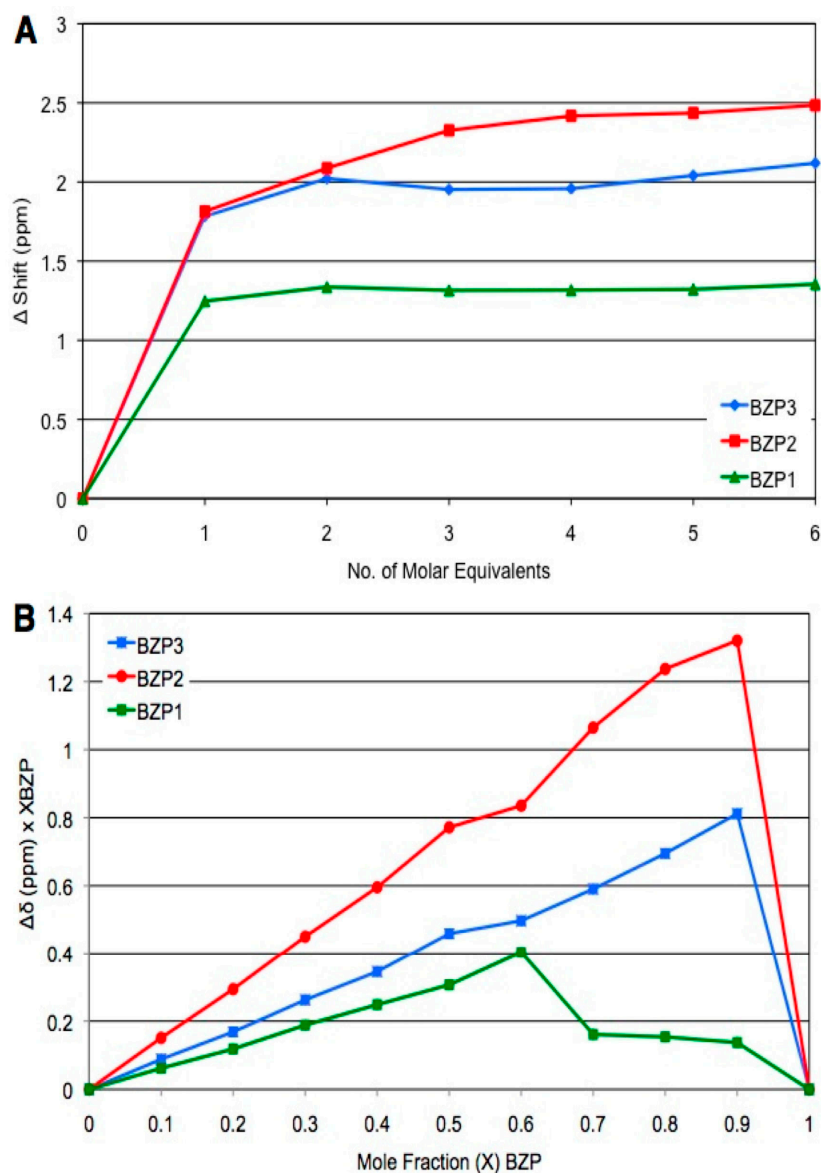
**Figure S9.** NMR analysis of benzylpiperazine (**BZP**, **1**) with acrylic acid (**AA**, **6**) showing, **A**) the  $^{13}\text{C}$  NMR spectra for the NMR titration of **BZP** with **AA** at a T:FM ratio of 1:0, 1:1 and 1:2; **B**) the changes in chemical shift of carbons 1 and 2 on benzylpiperazine (**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.  $^{13}\text{C}$  NMR spectra obtained at 28 °C in deuterated chloroform.



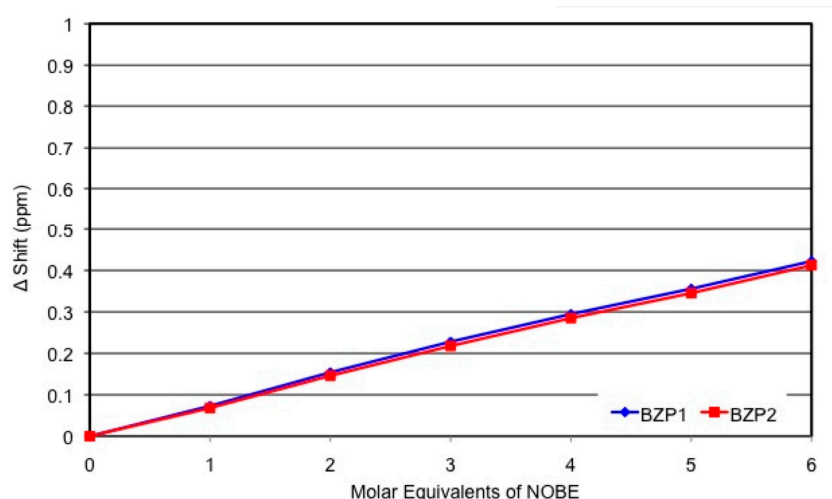
**Figure S10.** NMR analysis of benzylpiperazine (**BZP**, **1**) with methacrylic acids (**MMA**, **7**) showing, **A**) the  $^{13}\text{C}$  NMR spectra for the NMR titration of **BZP** (**1**) with **MAA** (**7**) at a T:FM ratio of 1:0 (no **7** added), 1:1 and 1:2; **B**) the changes in chemical 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.  $^{13}\text{C}$  NMR spectra obtained at 28 °C in deuterated chloroform.



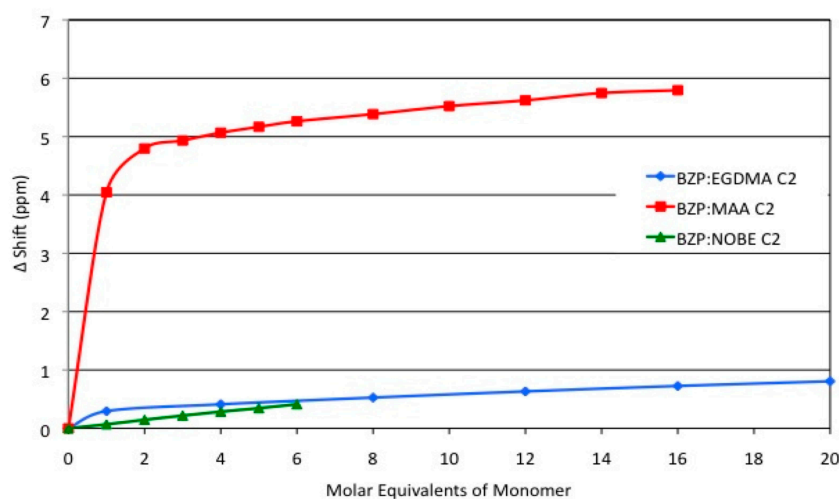
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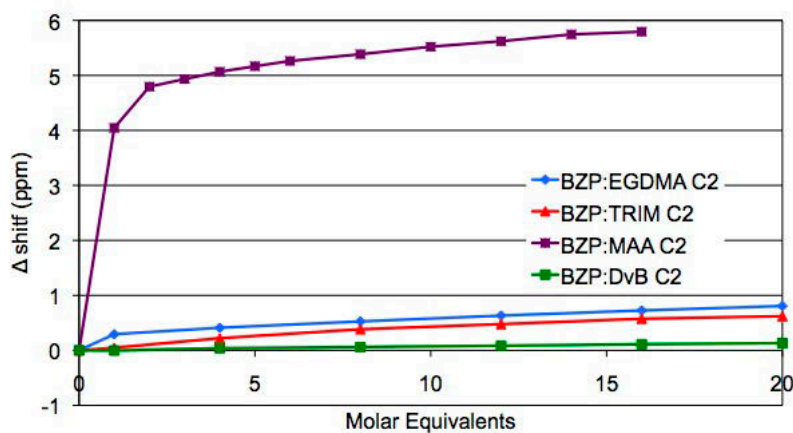
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**Figure S13.** NMR titration of benzylpiperazine (**BZP**, **1**) with N,O-bismethacroyloyl ethanolamine (**NOBE**, **14**) showing the changes in chemical shift of carbons 1 and 2 on **BZP** as a function of increasing **NOBE** concentration.

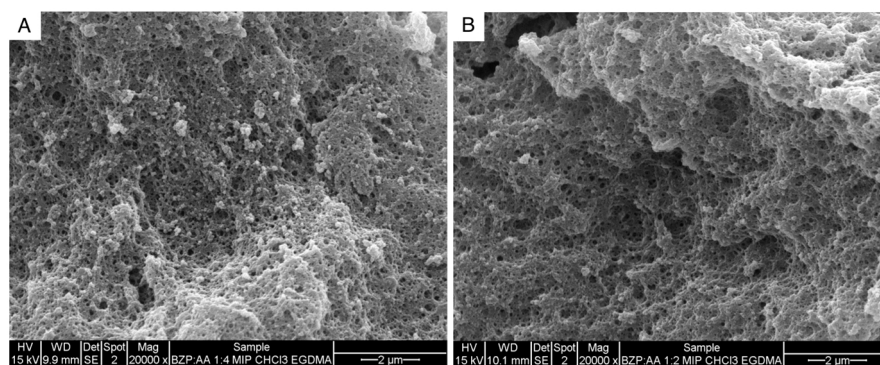


**Figure S14.** NMR titration of benzylpiperazine (**BZP**, **1**) with N,O-bismethacroyloyl ethanolamine (**NOBE**, **14**), methacrylic acid (**MAA**, **7**) and ethylene glycol dimethylacrylate (**EGDMA**) showing the changes in chemical shift of carbon 1 on **BZP** as a function of increasing monomer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

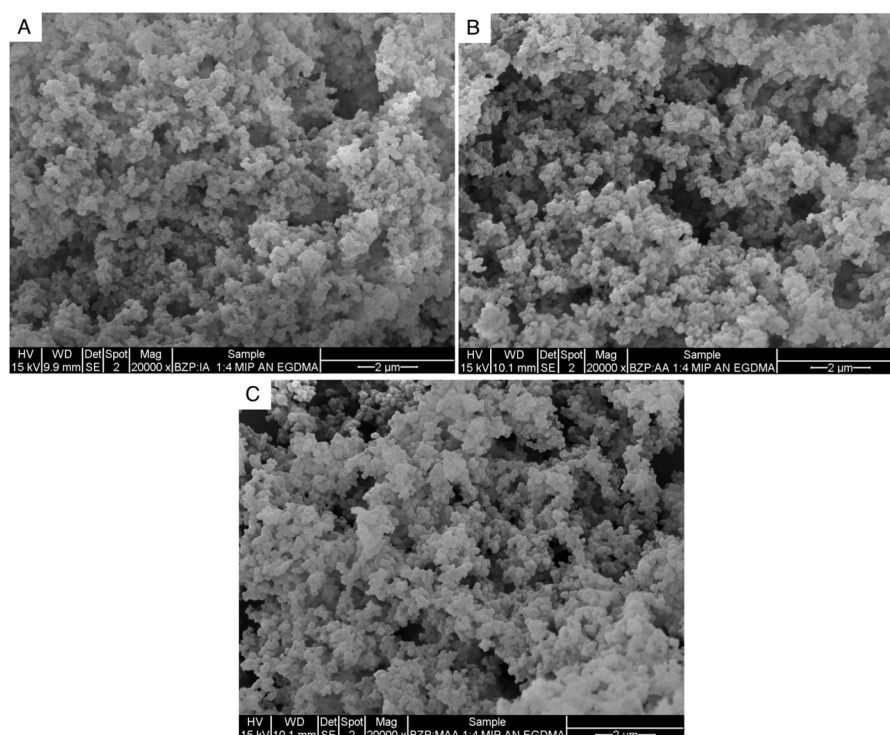


**Figure S15.** NMR titration of benzylpiperazine (**BZP**, **1**) with ethylene glycol dimethylacrylate (**EGDMA**), trimethylolpropane trimethylacrylate (**TRIM**), divinylbenzene (**DVB**) and methacrylic acid (**MAA**, **7**) showing the most significant change in chemical shift experienced as a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

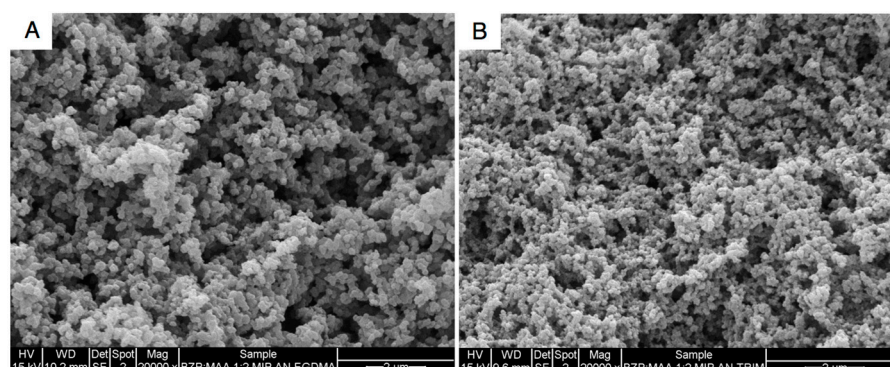




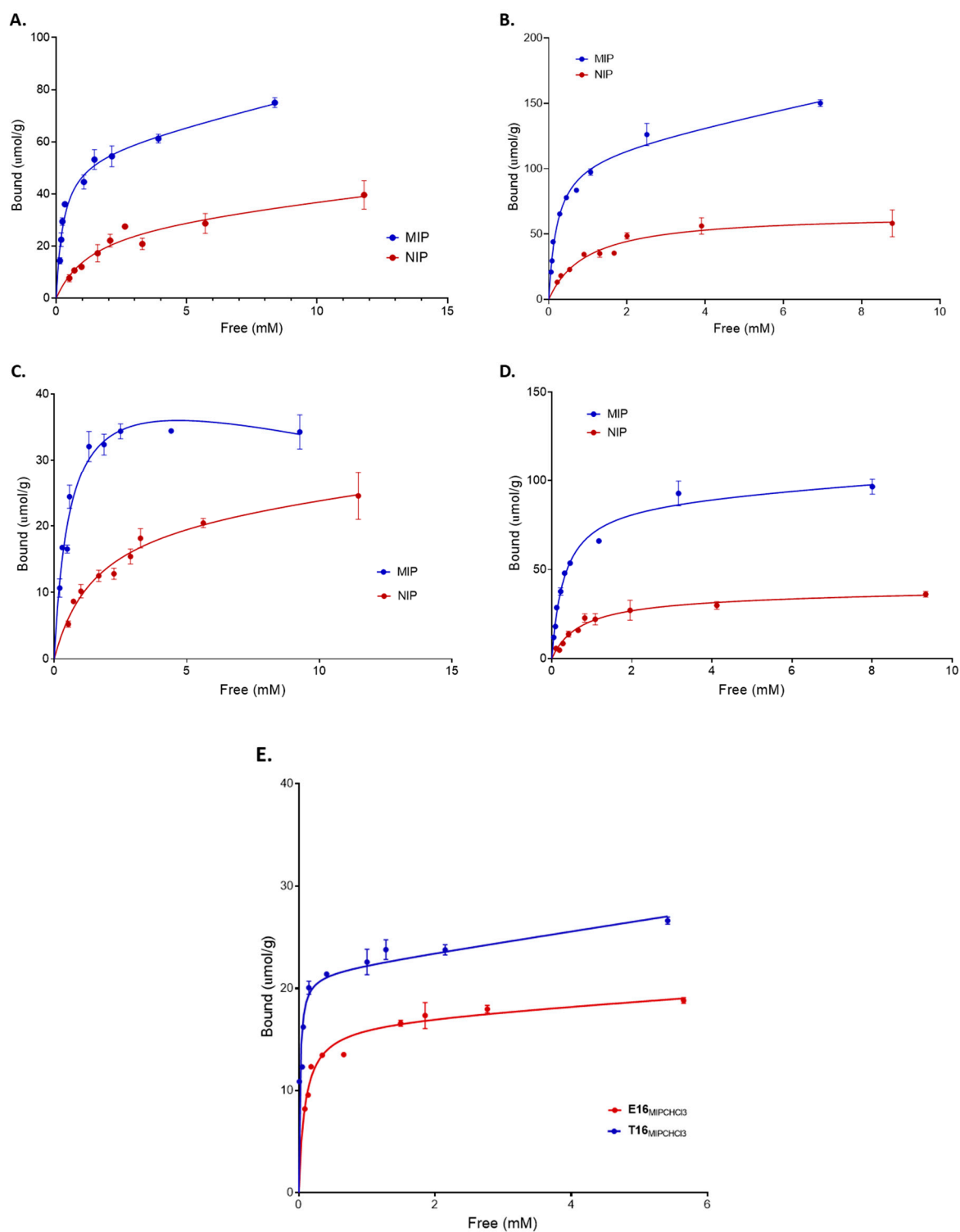
**Figure S16.** SEM images for A) E64-MIP<sub>CHCl3</sub> and B) E62-MIP<sub>CHCl3</sub> MIPs obtained at 20000x magnification at 15.0 kV.



**Figure S17.** SEM images for A) E124-MIP<sub>CH3CN</sub>, B) E64-MIP<sub>CH3CN</sub> and C) E74-MIP<sub>CH3CN</sub> MIPs obtained at 20000x magnification at 15.0 kV.

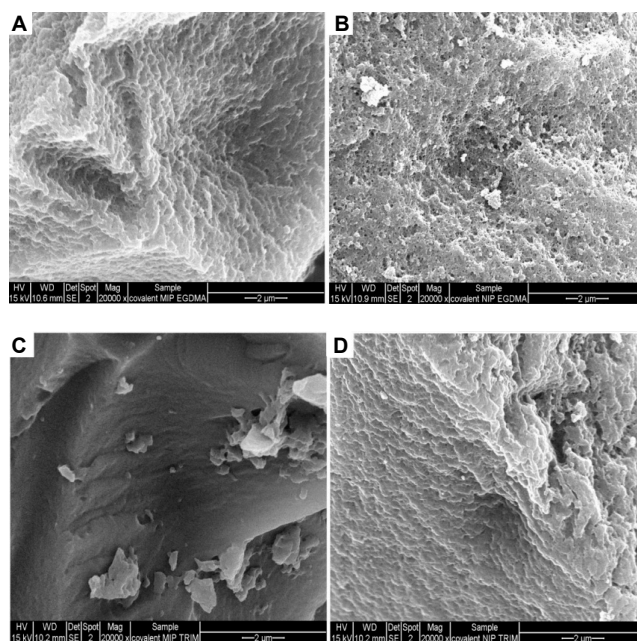


**Figure S18.** SEM images for A) E72-MIP<sub>CH3CN</sub>, and B) T72-MIP<sub>CH3CN</sub> MIPs obtained at 20000x magnification at 15.0 kV.

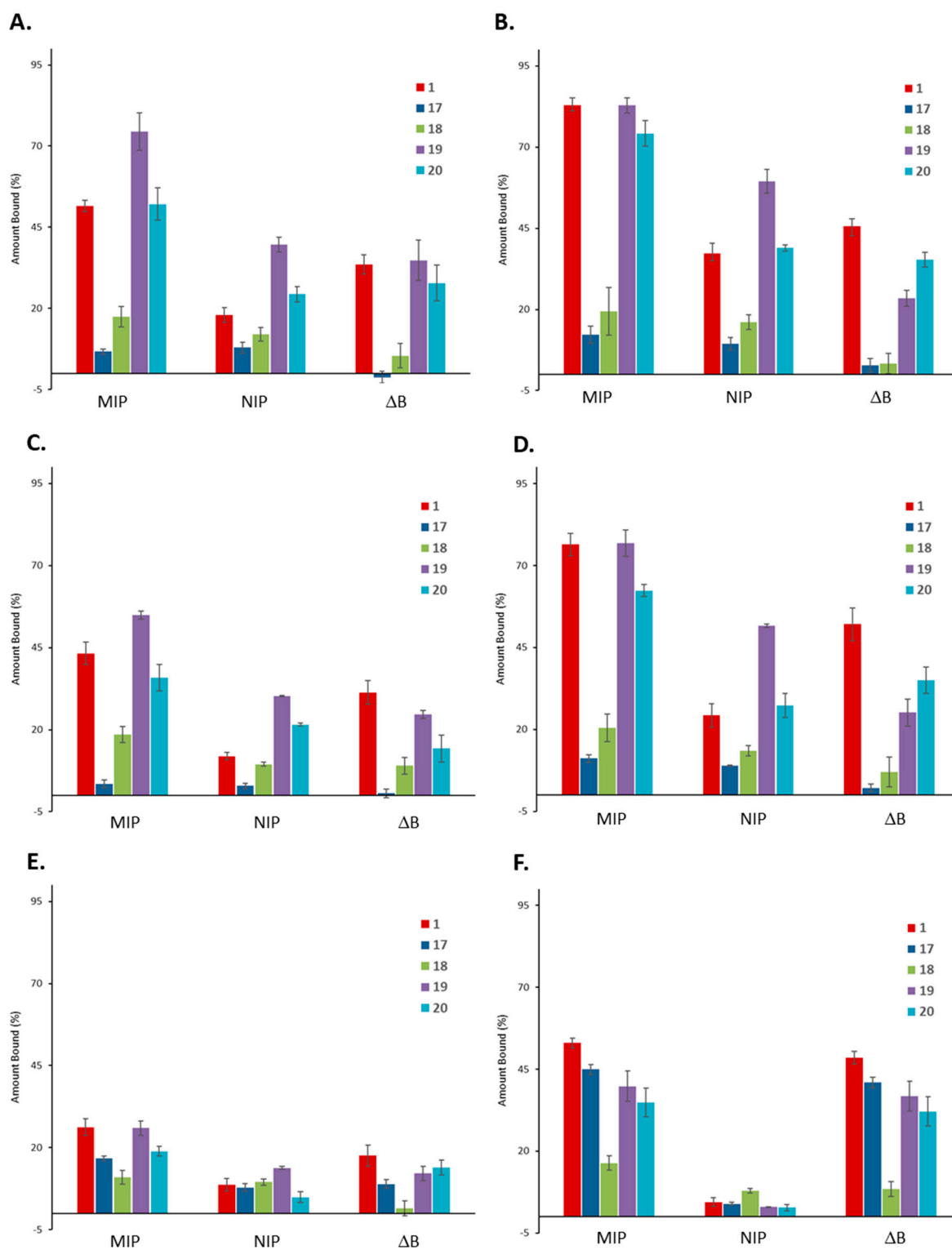


**Figure S19.** Binding isotherms produced for (A) E7<sub>1</sub>-MIPCHCl<sub>3</sub>; (B) E7<sub>2</sub>-MIPCHCl<sub>3</sub>; (C) T7<sub>1</sub>-MIPCHCl<sub>3</sub>; and (D) T7<sub>2</sub>-MIPCHCl<sub>3</sub> and (E) semi-covalent E16<sub>MIPCHCl<sub>3</sub></sub> and T16<sub>MIPCHCl<sub>3</sub></sub>.

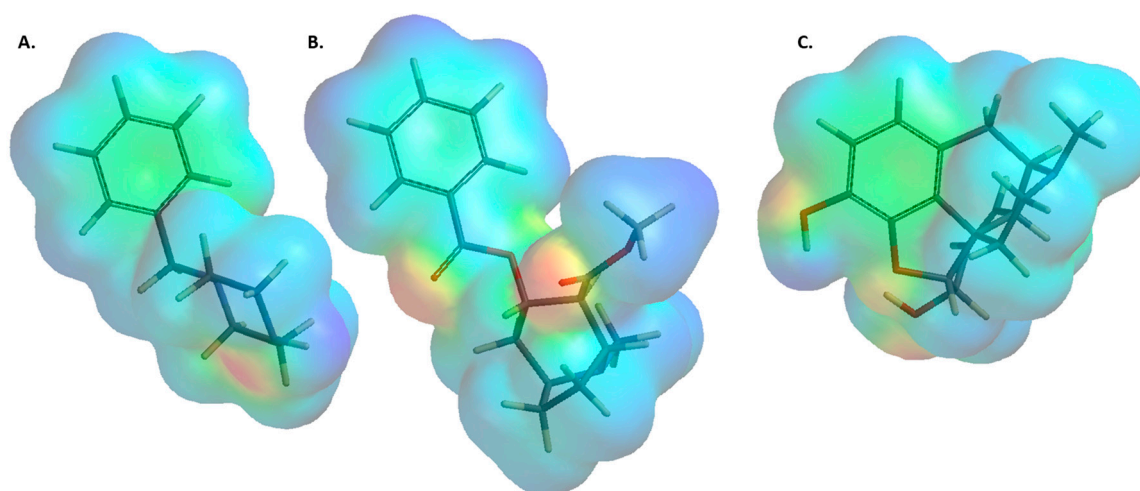




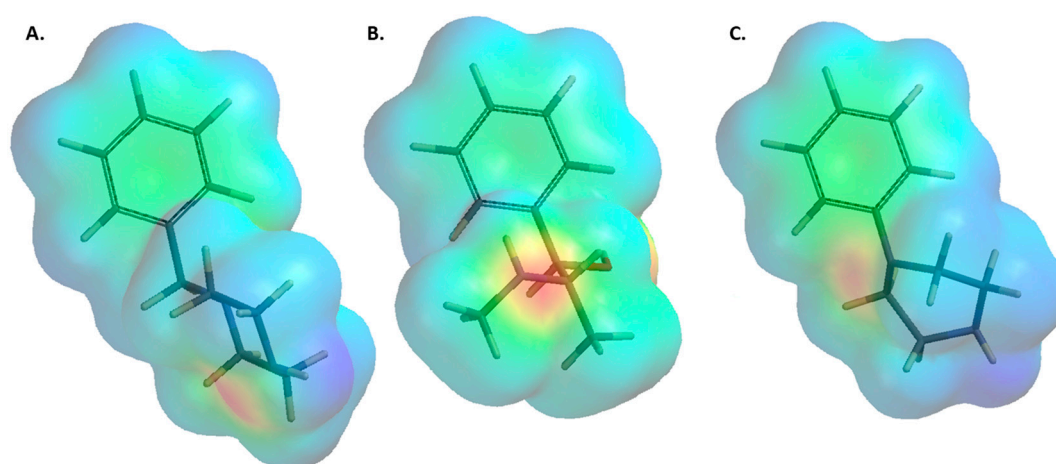
**Figure S20.** SEM images for (A) E16<sub>MIPCHCl3</sub>, (B) E<sub>NIP</sub>, (C) T16<sub>MIPCHCl3</sub> and (D) T<sub>NIP</sub>.



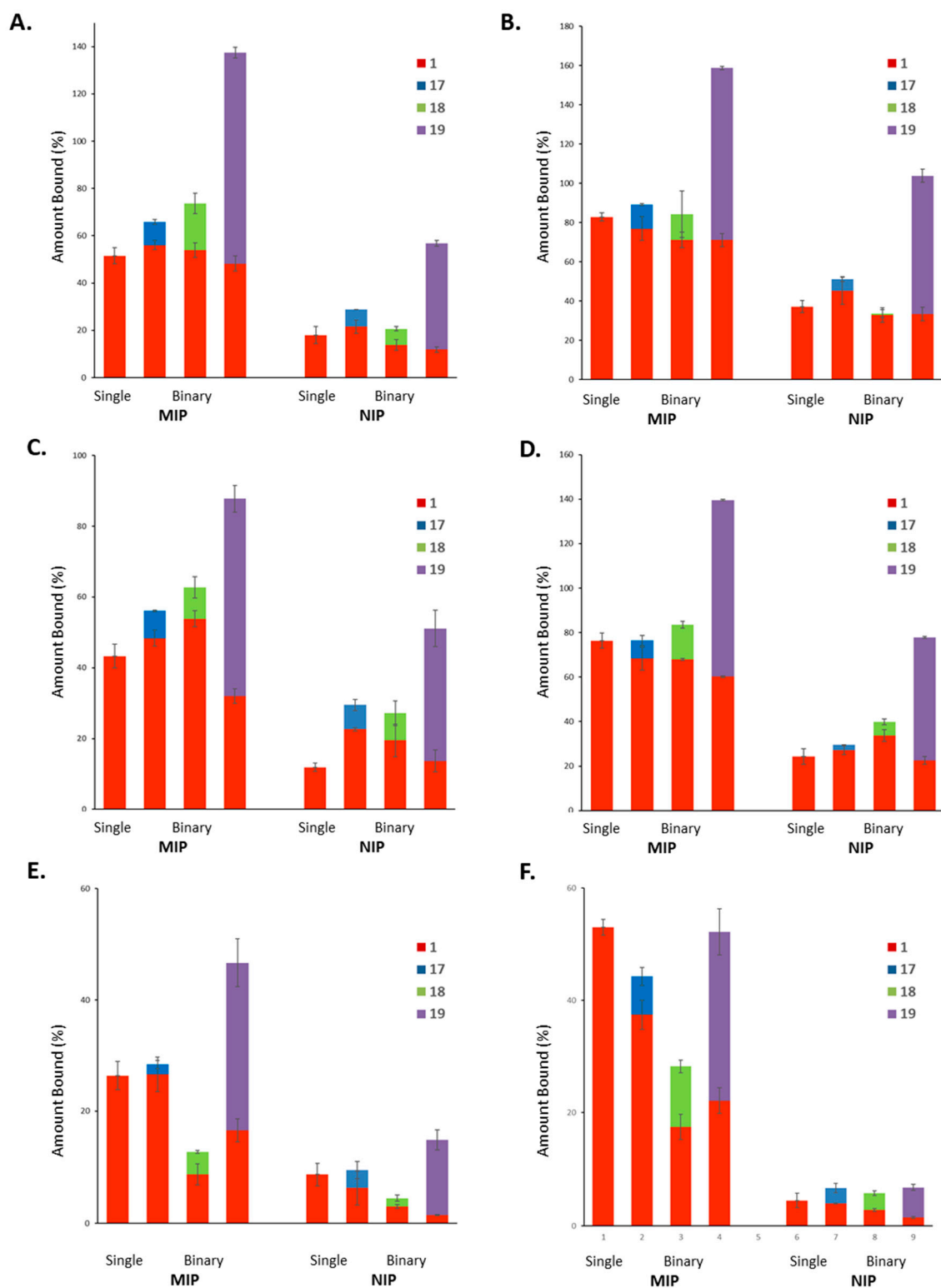
**Figure S21.** Cross-reactivity data for (A)  $E7_{1-MIPCHCl_3}$ ; (B)  $E7_{2-MIPCHCl_3}$ ; (C)  $T7_{1-MIPCHCl_3}$ ; (D)  $T7_{2-MIPCHCl_3}$ ; (E)  $E16_{MIPCHCl_3}$ ; and (F)  $T16_{MIPCHCl_3}$  using 20 mg of polymer and 0.8 mM analyte solutions at  $t = 60$  min in triplicate.



**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) E7<sub>1</sub>-MIPCHCl<sub>3</sub>; (B) E7<sub>2</sub>-MIPCHCl<sub>3</sub>; (C) T7<sub>1</sub>-MIPCHCl<sub>3</sub>; (D) T7<sub>2</sub>-MIPCHCl<sub>3</sub>; (E) E16<sub>MIPCHCl<sub>3</sub></sub>; and (F) T16<sub>MIPCHCl<sub>3</sub></sub> 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%.