# *Supporting Information*

# Computer-aided Design of Triazolo-Cages as Anion Receptors

*Minwei Che, Sibali Debnath, Amar H. Flood, and Krishnan Raghavachari**

Department of Chemistry, Indiana University, Bloomington IN 47405, USA

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## Iodine 6-311+G(3df) Basis Set Information

The following coefficients are formatted to be used in the *Gaussian16* program.[1]

```
I     0
S   5   1.00
 444750.0000000             0.0008900
  66127.0000000             0.0069400
  14815.0000000             0.0360900
   4144.9000000             0.1356800
   1361.2000000             0.3387800
S   2   1.00
    508.
4400000             0.4365900
    209.5900000             0.1837500
S   1   1.00
     81.9590000             1.0000000
S   1   1.00
     36.8050000             1.0000000
S   1   1.00
     13.4950000             1.0000000
S   1   1.00
      6.8859000             1.0000000
S   1   1.00
      2.5520000             1.0000000
S   1   1.00
      1.2088000             1.0000000
S   1   1.00
      0.2734000             1.0000000
S   1
1.00
      0.1009000             1.0000000
SP  1    1.00
      0.0252250             1.0000000
P   4   1.00
   2953.6000000             0.0122100
    712.6100000             0.0858700
    236.7100000             0.2949300
     92.6310000             0.4784900
P   1   1.00
     39.7320000             1.0000000
P   1   1.00
     17.2730000             1.0000000
P   1   1.00
      7.9570000             1.0000000
P   1   1.00
      3.1529000             1.0000000
```

```
P   1   1.00
      1.3328000              1.0000000
P   1   1.00
      0.4947000              1.0000000
P   1   1.00
      0.2160000              1.0000000
P   1   1.00
      0.0829300              1.0000000
D   3   1.00
    261.9500000              0.0314400
     76.7340000              0.1902800
     27.5510000              0.4724700
D   1   1.00
     10.6060000              1.0000000
D   1   1.00
      3.4217000              1.0000000
D   1   1.00
      1.1370000              1.0000000
D   1   1.00
      0.9060000              1.0000000
D   1   1.00
      0.3020000              1.0000000
D   1   1.00
      0.1006667              1.0000000
F   1   1.00
      0.4064000              1.0000000
****
```

## Calculated binding free energies of cage 1

**Table S1**. Calculated binding free energies of cage **1**, ΔG (kcal/mol), of cage **1** with $F^-$, $Cl^-$, $Br^-$, $I^-$, $NO_3^-$, and $SCN^-$ in gas, $CHCl_3$, DCM, acetone, MeCN, DMSO, and $H_2O$.

| Solvent | Dielectric constant ($\varepsilon_r$) | $F^-$ | $Cl^-$ | $Br^-$ | $I^-$ | $NO_3^-$ | $SCN^-$ |
|---|---|---|---|---|---|---|---|
| Gas phase | 1 | −80.02 | −64.66 | −57.44 | −43.62 | −53.27 | −45.42 |
| $CHCl_3$ | 4.71 | −25.06 | −20.35 | −15.75 | −8.64 | −15.50 | −12.86 |
| DCM | 8.93 | −17.52 | −13.50 | −9.35 | −3.39 | −10.01 | −7.94 |
| Acetone | 20.49 | −11.12 | −9.21 | −5.44 | −0.02 | −5.90 | −4.80 |
| MeCN | 35.69 | −9.82 | −8.00 | −4.65 | 0.78 | −5.19 | −4.27 |
| DMSO | 46.83 | −9.36 | −7.89 | −4.35 | 0.79 | −4.81 | −4.02 |
| $H_2O$ | 78.36 | −9.19 | −7.22 | −3.78 | 1.57 | −4.10 | −3.54 |

## SAPT Energy decomposition of cage complexes

**Table S2.** Energy decomposition of anion complexes formed with cages receptors in the gas phase (kcal/mol).

| Complex | Total sSAPT0 | Electrostatics | Exchange | Induction | Dispersion |
|---|---|---|---|---|---|
| **1**•F⁻ | −103.12 | −80.96 | 21.26 | −35.00 | −8.42 |
| **1**•Cl⁻ | −83.78 | −82.52 | 51.26 | −32.13 | −20.40 |
| **1**•Br⁻ | −76.57 | −83.81 | 64.79 | −32.25 | −25.30 |
| **1**•I⁻ | −61.28 | −77.33 | 74.44 | −28.88 | −29.50 |
| **1**•$NO_3^-$ | −75.30 | −71.95 | 44.67 | −26.40 | −21.62 |
| **1**•SCN⁻ | −64.71 | −55.80 | 42.43 | −23.46 | −27.89 |
| **2**•Cl⁻ | −76.05 | −75.40 | 51.69 | −32.39 | −19.95 |
| **3**•Cl⁻ | −77.02 | −77.71 | 53.09 | −32.14 | −20.25 |
| **4**•Cl⁻ | −82.08 | −81.43 | 50.5 | −31.14 | −20.01 |
| **5**•Cl⁻ | −75.35 | −62.61 | 25.2 | −24.80 | −13.15 |
| **6**•Cl⁻ | −77.52 | −63.89 | 26.22 | −25.76 | −14.09 |
| **7**•Cl⁻ | −81.48 | −79.86 | 51.29 | −32.44 | −20.47 |

## Benchmarking of calculations

The computed binding free energies of cage **1** with Cl⁻, Br⁻, I⁻, and $NO_3^-$ are compared to the experimental values obtained from titrations in DMSO as reported by Liu et al.[2] As shown in Figure S1, the computational method successfully reproduces the experimental trend, yielding a slope of 0.99. While it consistently underestimates binding free energies, we believe a correction based on linear regression can account for this systematic error. Since the primary goal of this study is to showcase a computer-aided method to design cage receptors with tunable affinities, we focus on comparisons among computational binding energies. Hence, the reported values remain uncorrected. Nonetheless, we recommend applying linear error correction when using predicted binding energies to inform synthesis.

Table S3. Comparison between experimental and calculated binding free energies of cage 1.

| | $\Delta G_{\mathrm{expt}}$ (kcal/mol) | $\Delta G_{\mathrm{calc}}$ (kcal/mol) | Error[a] (kcal/mol) |
|---|---|---|---|
| $Cl^-$ | −10.66 | −7.89 | 2.77 |
| $Br^-$ | −7.36 | −4.35 | 3.01 |
| $I^-$ | −2.15 | 0.79 | 2.94 |
| $NO_3^-$ | −5.89 | −4.81 | 1.08 |

[a]Errors are calculated by: $\Delta G_{\mathrm{calc}} - \Delta G_{\mathrm{expt}}$.

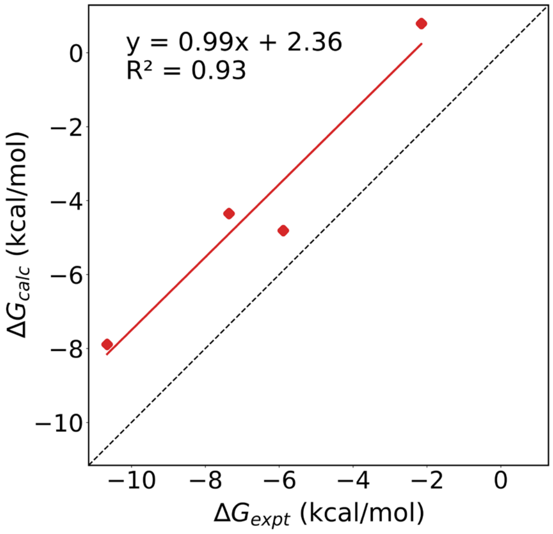

Figure S1. Comparison of $\Delta G_{\mathrm{expt}}$ and $\Delta G_{\mathrm{calc}}$. The diagonal dotted line represents $\Delta G_{\mathrm{expt}} = \Delta G_{\mathrm{calc}}$.

## The $1/\varepsilon_r$ dependence of binding free energies of cage 1

Solvent effects were accounted for using the conductor-like polarizable continuum model (CPCM).[3] Single-point energies were obtained with larger basis sets to compute the binding affinities. In these calculations, the 6-311++G(3df,2p) basis set was used for the cage atoms, the *aug*-cc-pVTZ basis set for the anion atoms,[4-6] except for bromine and iodine atoms, for which the *aug*-cc-pVTZ-PP basis set[7, 8] where pseudopotentials describing the inner core orbitals were used.

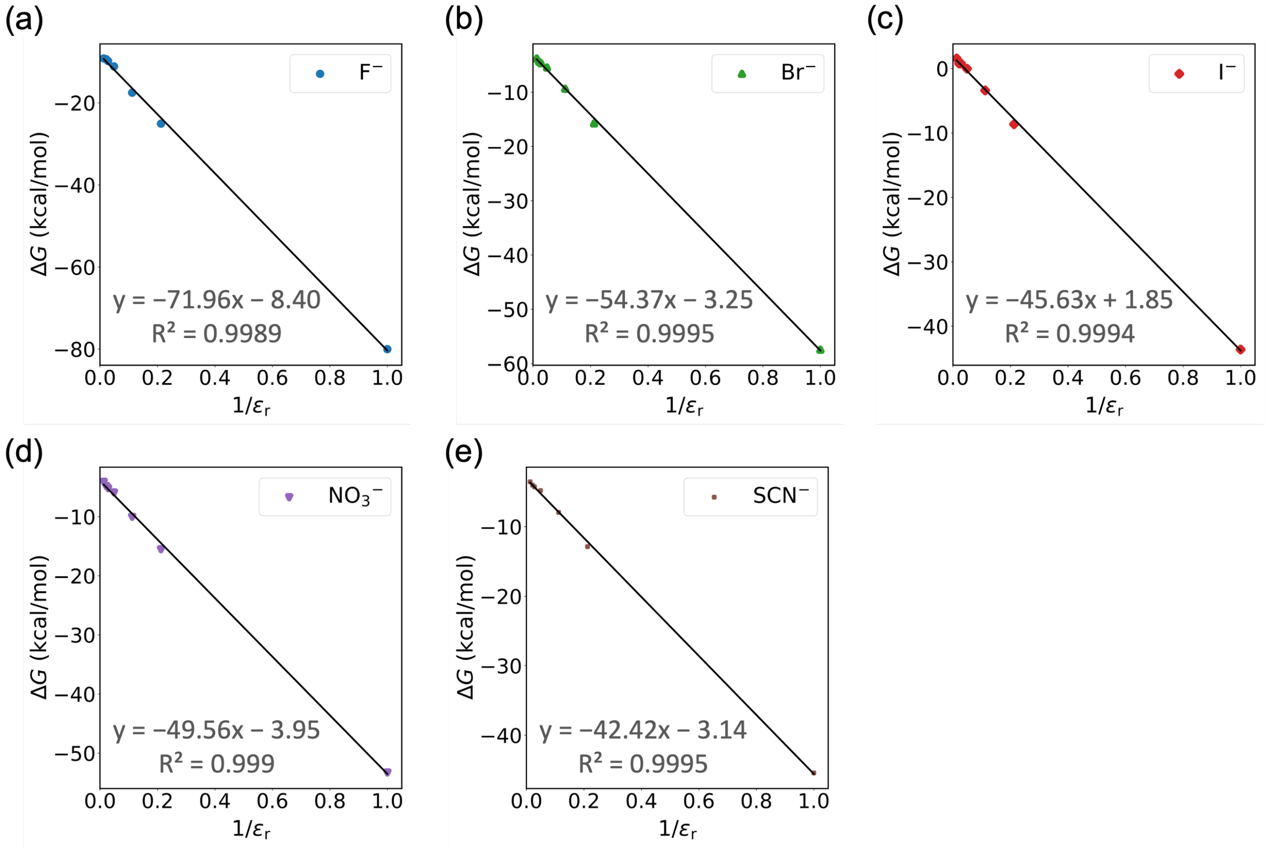

***Figure S2.*** Plots of binding free energies versus inverse of the solvent dielectric constant $1/\varepsilon_r$. (a) **1**•$F^-$, (b) **1**•$Cl^-$, (c) **1**•$I^-$, (d) **1**•$NO_3^-$, and (e) **1**•$SCN^-$.

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