Supporting Information: Cavity Click Chemistry: Cavity-Catalyzed Azide–Alkyne Cycloaddition

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1 Reaction Diagram of 1,3-dipolar Huisgen Cycloaddition Calculated Employing the 6-311G(d,p) Basis Set

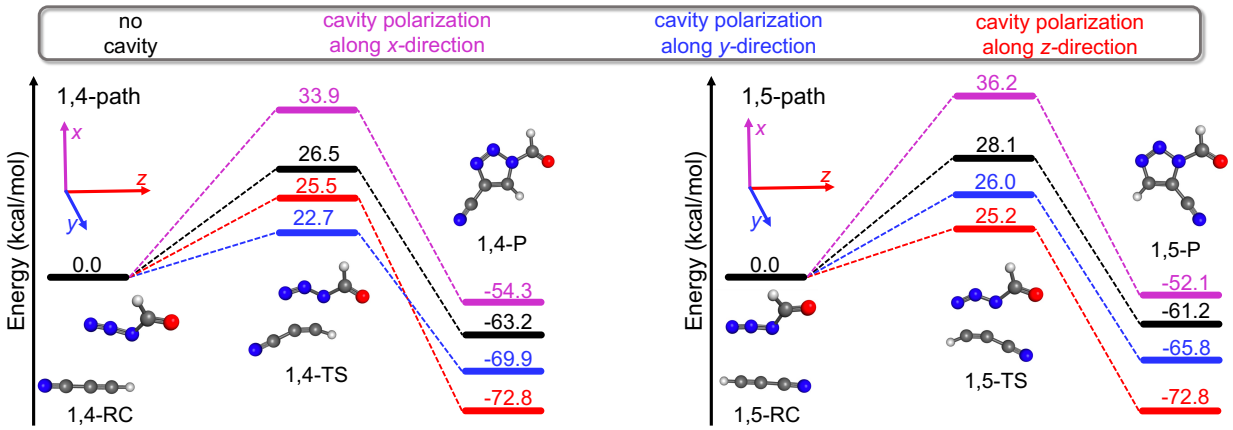

Figure S1: Reaction diagram of 1,3-dipolar Huisgen cycloaddition reaction between cyanoacetylene and formylazide for 1,4-path (left panel) and 1,5-path (right panel) calculated with the QED-CCSD/6-311G(d,p) method. The QED-CCSD calculations employ the cavity parameters $\omega = 1.5$ eV and $|\lambda| = 0.1$ a.u. with the photon mode polarized in the x (magenta, along the forming C-N bond), y (blue, perpendicular to the triazole ring plane), and z (red, in the plane of the triazole ring) molecular directions. The no cavity (CCSD) calculations are in black. The panels contain the structures of the reaction complex (RC), transition state (TS), and product (P), along with the molecular coordinate frame.

Figure S1 shows the reaction energy diagram for the 1,3-dipolar Huisgen cycloaddition reaction between cyanoacetylene and formylazide along the 1,4-path (left panel) and 1,5-path (right panel) calculated with the conventional electronic CCSD/6-311G(d,p) method (black) which we also refer to as 'no cavity', and with the QED-CCSD/6-311G(d,p) method with the cavity mode polarized in the molecular x (magenta), y (blue), and z (red) directions with respect to the molecular coordinate frame indicated in Fig. S1. As given in Fig. S1 (in black), the activation energy for the gas phase reaction calculated with the CCSD method along the 1,4-path is lower by 1.6 kcal/mol than for the 1,5-path. In the case where the cavity mode is polarized in the molecular x-direction ($\omega = 1.5$ eV and $|\lambda| = 0.1$ a.u.), which corresponds to the C-N bond forming direction and in the plane of the forming triazole ring (see Fig. S1), the

reaction activation energy increases by 7.4 kcal/mol and 8.1 kcal/mol along the 1,4-path and 1,5-path, respectively. Now if the cavity mode is polarized along the molecular y-direction, which is perpendicular to the plane of the forming triazole ring, the activation energy along the 1,4-path is lowered by 3.8 kcal/mol, whereas for the 1,5-path by 2.1 kcal/mol. When the cavity mode is polarized along the molecular z-direction, the activation energy along the 1,4-path is decreased by 1.0 kcal/mol, whereas along the 1,5-path, the activation energy is decreased by 2.9 kcal/mol. Lastly, we discuss the effect of a cavity on the reaction energy. The reaction along 1,4-path and 1,5-path inside an optical cavity with the mode polarized along the molecular x-direction becomes less exothermic by 8.9 kcal/mol and 9.1 kcal/mol, respectively. If the cavity mode is now polarized along the molecular y-direction, the reaction along both 1,4-path and 1,5-path becomes more exothermic by 6.7 kcal/mol and 4.6 kcal/mol, respectively. When the cavity is polarized along the molecular z-direction, the reaction along the 1,4-path and 1,5-path is stabilized by 9.6 kcal/mol and 11.6 kcal/mol, respectively.

2 Cartesian Coordinates of the Optimized Geometries

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,4-reaction complex; number of imaginary frequencies = 0

C	0.0000000000	0.0000000000	0.0000000000
C	-0.0689579136	0.0654336272	1.2191330999
C	-0.1504197849	0.1394453601	2.6143032338
N	-0.2179449349	0.2100331355	3.7833745793
H	0.0600823981	-0.0404791198	-1.0757795925
N	-0.2843637809	3.5558030006	1.0735897550
N	-0.0000000000	3.3291564418	0.0000000000
N	0.2164816998	2.9697336705	-1.1922954114
C	1.3189082914	3.6663756301	-1.7713489350
O	1.6968341120	3.4261454875	-2.8846097763
H	1.7827490289	4.4351654319	-1.1071480393

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,4-transition state; number of imaginary frequencies = 1

C	0.0000000000	0.0000000000	0.0000000000
C	-0.0000000000	0.0000000000	1.2624276159
C	-0.0392920129	-0.4753395108	2.5723082275
N	-0.0704117205	-0.8912400006	3.6868670299
H	-0.0188729514	-0.4620320883	-0.9787069053
N	0.1844435440	2.1603003335	1.6792702527
N	0.2268257759	2.4749367328	0.5374121207
N	0.0855116300	1.8997609175	-0.5980574816
C	0.9596247223	2.1979425392	-1.6851084076
O	1.0623026589	1.4375488157	-2.6185649757

H	1.4755812740	3.1759983591	-1.5875317823

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,4-product; number of imaginary frequencies = 0

C	0.0000000000	0.0000000000	0.0000000000
C	0.0000000000	-0.0000000000	1.3881296991
C	-0.0271267780	-1.1304492834	2.2669855151
N	-0.0498180917	-2.0810527961	2.9764482734
H	-0.0196652100	-0.7796627286	-0.7566559263
N	0.0311889279	1.2978372295	1.8559467136
N	0.0505558140	2.1042993900	0.8168238246
N	0.0322943454	1.3318558423	-0.3006329808
C	0.0453335733	1.9665933679	-1.5864369548
O	0.0278926123	1.3363893821	-2.6124975148
H	0.0721008557	3.0669374191	-1.4683378120

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,5-reaction complex; number of imaginary frequencies = 0

C	0.0000000000	0.0000000000	0.0000000000
C	0.0000000000	0.0000000000	1.2351186993
C	0.0044036563	-0.0266866180	2.6203873493
N	0.0129253056	-0.0688083419	3.8115684119
H	-0.0017804843	-0.0031792295	-1.0762061501
N	0.0567666113	3.0656960102	-0.6025029252
N	0.0422907378	3.1242841148	0.5562978229
N	-0.0821302911	3.0495500165	1.7959171162
C	0.7820876976	3.8963530691	2.5619753553
O	0.7537779133	3.8989695090	3.7652679595

H	1.4577459185	4.5285648328	1.9386650051

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,5-transition state; number of imaginary frequencies = 1

C	0.0000000000	0.0000000000	0.0000000000
C	0.0000000000	-0.0000000000	1.2672303593
C	-0.0266096843	-0.6376415802	2.5092178597
N	-0.0483741335	-1.1963320626	3.5621997695
H	-0.0360897130	-0.4398487258	-0.9855336498
N	0.0756917704	1.9072846037	-0.5630238344
N	0.1220088366	2.4389516416	0.5017549614
N	0.0241710551	2.0443017096	1.7082062867
C	0.7997693924	2.6507745462	2.7468883645
O	0.9214759346	2.1244249577	3.8247622734
H	1.2269932205	3.6326883399	2.4511137817

Optimized with the CCSD/cc-pVDZ method:

cyanoacetylene with formylazide 1,5-product; number of imaginary frequencies = 0

C	0.0000000000	0.0000000000	0.0000000000
C	-0.0000000000	0.0000000000	1.3951227811
C	-0.0578694336	-1.0642352914	2.3384373779
N	-0.1089978524	-1.9958052597	3.0746315027
H	-0.0461222549	-0.8524361674	-0.6745728614
N	0.0702029404	1.2864584586	-0.4510914509
N	0.1145998108	2.1012155121	0.5861458352
N	0.0723908186	1.3351295797	1.7090414367
C	0.1107133322	1.9901444873	2.9867630369
O	0.0798640144	1.3868659222	4.0275138249

H	0.1702104614	3.0859278270	2.8389084043