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Solvent-Directed Transition Metal-Free C−C Bond Cleavage by Azido-1,3,5-triazines and Their Stability-Reactivity Paradox

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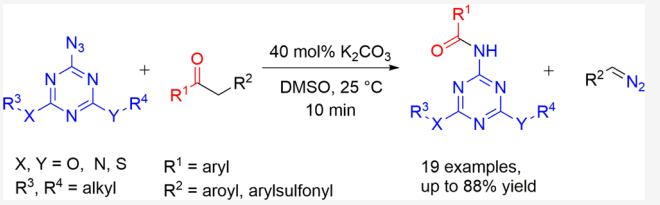
ABSTRACT: We report a solvent-directed and regioselective carbon−carbon bond cleavage of aryl ketones by azido-1,3,5-triazines (ATs), which is typically completed within 10 min in DMSO at room temperature, without using transition metal catalysts. The cleavage is driven by the steric hindrance in the adducts of aryl ketones and ATs, which is substantiated by DFT calculation. Our recent results showed that ATs present high reactivity in solution and high stability in solid state. This "stability-reactivity paradox" has been explained in light of the molecular and crystal structures of ATs.

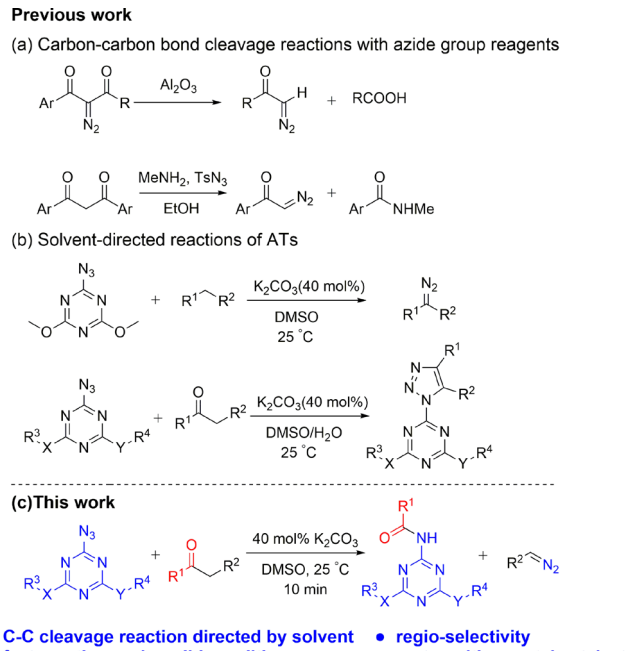


INTRODUCTION

Selective carbon−carbon bond (C−C) cleavage reactions have been utilized as powerful tools for the installation of functional groups and new connections.[1,2] Typically, C−C cleavage is achieved by β-scission of radicals[3−6] or cleavage of strained rings.[7−10] Since most of these cleavage reactions need transition metals as catalysts[11,12] and harsh reaction conditions, selective cleavage of unstrained C−C bonds at ambient conditions without using transition metal catalysts remains as a challenge.

Recently, tosyl azide (TsN_3) was utilized to accomplish C−C cleavage of 1,3-diketo compounds (Scheme 1a), which first generates 2-diazo-1,3-diketone and then achieves C−C cleavage with Al_2O_3[13] or amines.[14,15] In our previous work, we reported azido-1,3,5-triazines (ATs) reacting with 1,3-diketo compounds (Scheme 1b) to efficiently achieve diazo transfer in aprotic solvents[16] or cyclization in protic solvents,[17] where the reaction pathway is determined by the fate of a nitride anion intermediate. Herein, we report a new pathway for the reaction between aryl ketones and ATs in aprotic solvents: a regioselective C−C cleavage of aryl ketones by ATs (Scheme 1c). In contrast, the reaction between aryl ketones and ATs in protic solvents leads to the cyclization product: 1,2,3-triazoles,[17] which indicates that the reaction pathway is directed by solvents. In addition, our recent results have shown that ATs present high reactivity in solution and high stability in solid state.[16,17] This "stability-reactivity paradox" has been explained by the molecular and crystal structures of ATs.

Scheme 1. C−C Cleavage Reactions with Azide Reagents and Previously Reported AT-Based Reactions



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RESULTS AND DISCUSSION

We discovered this C−C cleavage reaction of aryl ketones when performing the reaction between 2-azido-4,6-dimethoxy-1,3,5-triazines (ADT) and 1,3-diphenyl-1,3-propanedione (**2a**). In a protic solvent (water/DMSO 1:1 mixture), the

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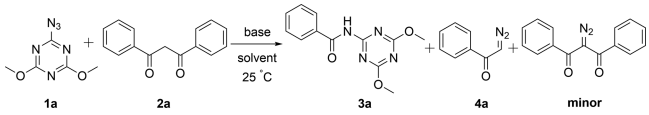
fast cyclization reaction between ADT and **2a** gives a 1,2,3-triazole product with high yield.[17] Surprisingly, when using DMSO as the solvent, we did not get the diazo transfer product as the major product, as expected based on a previous study.[16] Instead, we found two new products: amide (**3a**) and diazo-phenylethanone (**4a**) (Table 1), which suggested that a C−C bond cleavage reaction occurred on **2a**.

Table 1. Optimization of C−C Bond Cleavage Reaction of Aryl Ketones and ADT[a,b]



entry	solvent	base	time (min)	3a yield[b] (%)	4a yield[b] (%)
1	DCM	K_2CO_3	120	no reaction	
2	chloroform	K_2CO_3	120	no reaction	
3	THF	K_2CO_3	60	64%	58%
4	1,4-dioxane	K_2CO_3	60	64%	60%
5	acetone	K_2CO_3	60	73%	60%
6	MeCN	K_2CO_3	60	47%	37%
7	DMF	K_2CO_3	10	66%	47%
8	DMSO	K_2CO_3	10	71%	38%
9	DMSO	Et_3N	120	59%	51%
10	DMSO	$NaHCO_3$	60	66%	50%
11	DMSO	Na_2CO_3	60	67%	51%
12	DMSO	Cs_2CO_3	10	64%	45%
13	DMSO	KOH	10	65%	39%
14	DMSO	t-BuOK	10	64%	51%
15	DMSO	LiOH	120	63%	51%

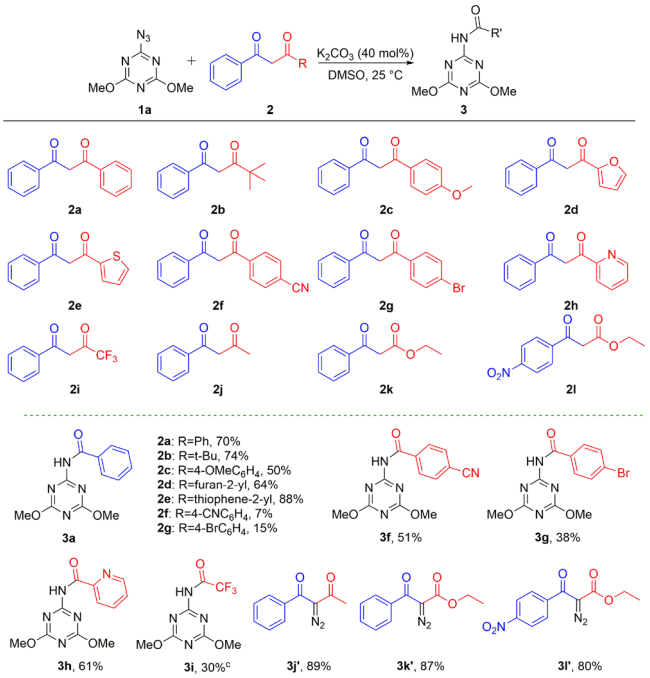
[a]Conditions: phenylphenacylketone **2a** (0.5 mmol, 1.0 equiv), ADT **1a** (0.5 mmol, 1.0 equiv), and base (0.2 mmol, 0.4 equiv) in solvent (2 mL), 25 °C. [b]The yield was determined by using ^{1}H NMR with mesitylene as the internal standard.

To optimize the reaction condition between ADT and **2a**, we first examined the effect of solvent and bases. As shown in entries 1−8 (Table 1), we tried eight different aprotic solvents with K_2CO_3 as the base. The major products were **3a** and **4a**, which suggests that the dominating reaction is C−C cleavage of aryl ketones in aprotic solvents. With the increase in the solvent polarity, the C−C cleavage is accelerated (from 1 h in entries 3−6 to 10 min in entries 7 and 8). In DCM and chloroform, the reaction was too slow that no product was detected in 2 h, which could be because of the poor solubility of K_2CO_3 in these two solvents. The yield of diazo compound **4a** is often lower than that of amide **3a**, which is probably due to the low stability of **4a** in basic conditions.[18]

Then, we explored the effect of different bases on this reaction in DMSO. When an organic base (entry 9) was used, the reaction was much slower than that with inorganic bases. For inorganic bases (entries 10−14), the reaction rate increased along with the increase in basicity of the base. For strong inorganic bases (entries 12−14, Cs_2CO_3, KOH, and t-BuOK), the reaction rate and the yield of **3a** were similar with those of K_2CO_3, but the yield of **4a** was diminished, possibly due to the low stability of **4a** with strong bases.[18] In addition, although LiOH is a stronger base than K_2CO_3, the reaction with LiOH (entry 15) was much slower than that of K_2CO_3, possibly because the nucleophilic activity of the enolate of **2a** was decreased by the coordination of Li^+ and the enolate.[16] At an optimal condition (0.25 M aryl ketone and 0.25 M ADT in DMSO with 40 mol % K_2CO_3), the C−C cleavage reaction is typically completed within 10 min at room temperature with a good yield.

To explore the structure scope of this C−C bond cleavage reaction, we have tested a variety of aryl 1,3-diketones as listed in Scheme 2. The results suggest that aryl diketones with bulky

Scheme 2. Regioselectivity of the C−C Cleavage Reaction in Asymmetric Aryl 1,3-Diketones[a,b]



[a]Reaction conditions: ADT (1 mmol, 1.0 equiv), aryl 1,3-diketone **2** (1 mmol, 1.0 equiv), and K_2CO_3 (0.4 mmol, 0.4 equiv) in DMSO (4 mL) reacted at 25 °C for 10 min. [b]Isolation yields. [c]Reacted for 20 min.

groups favor C−C cleavage reaction (**3a−i**), while aryl diketones with small groups prefer diazo transfer reaction (**3j′−3l′**). For asymmetric aryl 1,3-diketones, it is important to probe the regioselectivity. Electron-donating groups, such as t-Bu (**2b**), 4-methoxyphenyl (**2c**), furan (**2d**), and thiophene (**2e**), would increase the electron density of the adjacent carbonyl, making it less possible to be attacked by the nitride anion, as discussed later in the proposed mechanism. Thus, the nitride anion attacks the carbonyl adjacent to a phenyl group, which leads to the formation of **3a**. In contrast, electron-withdrawing groups, such as 4-cyanophenyl (**2f**), 4-bromophenyl (**2g**), pyridine (**2h**), and trifluoromethyl (**2i**), make the adjacent carbonyl electron-deficient and easier to be attacked by the nitride anion, which leads to the formation of **3f−3i**.

We have also explored the reaction between **2a** and different ATs. As shown in Scheme 3, a 1,3,5-triazine ring in ATs can be substituted by alkoxy (**1a**, **b**, and **d**), amino (**1c**), and thiol (**1e** and **f**) groups, which affect the electron density of the 1,3,5-triazine ring and tune the activity of ATs. Under optimal reaction conditions, all of these ATs (**1a−f**) provide the corresponding C−C cleavage products. Among them, the AT with an amino group (**1c**) offers the highest yield of amide (83%), while the ATs with a thiol group (**1e** and **f**) present low yield (<50%). In addition, the ester group in **1b−f** can be

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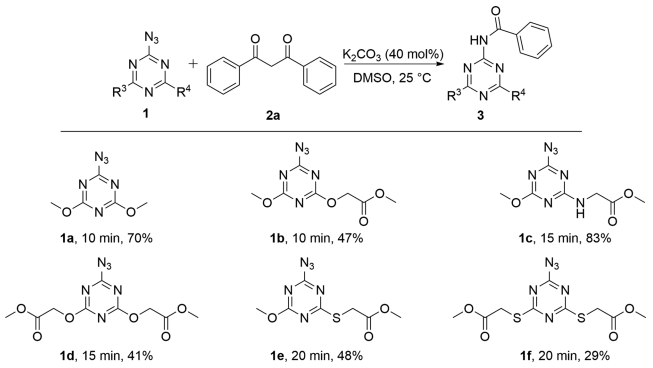
Scheme 3. The Reactivity of Different Azido-1,3,5-triazines[a,b]

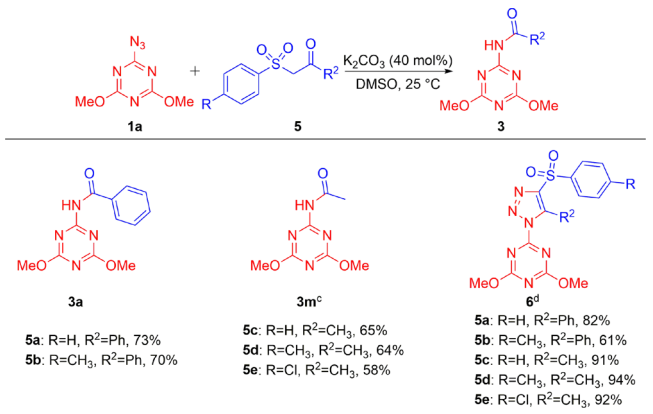


[a]Reaction conditions: azido-1,3,5-triazine **1** (1 mmol, 1.0 equiv), **2a** (1 mmol, 1.0 equiv), and K_2CO_3 (0.4 mmol, 0.4 equiv) in DMSO (4 mL), at 25 °C, finished in 10−20 min as indicated. [b]Isolation yields.

easily modified to conjugate with other functional molecules through ester or amide bonds.

To further expand the scope of this C−C cleavage reaction, we have also explored more aryl ketones and found sulfonyl aryl ketones (**5a**−**e**) as good substrates (Scheme 4). In these

Scheme 4. Solvent-Directed Reaction between ADT and Sulfonyl Aryl Ketones[a,b]

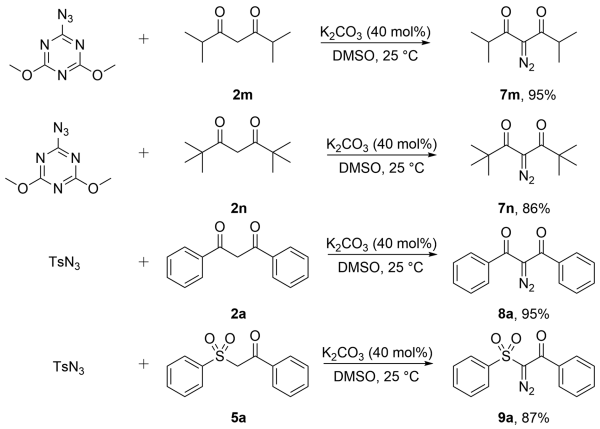


[a]Reaction conditions: ADT **1a** (1 mmol, 1.0 equiv), sulfonyl-substituted aryl ketones **5** (1 mmol, 1.0 equiv), and K_2CO_3 (0.4 mmol, 0.4 equiv) in DMSO (4 mL) reacted at 25 °C for 10 min. [b]Isolation yields. [c]Reacted for 20 min. [d]Reaction conditions: ADT **1a** (1 mmol, 1.0 equiv), **5** (1 mmol, 1.0 equiv), and K_2CO_3 (0.4 mmol, 0.4 equiv) in DMSO/H_2O = 1:1 (4 mL) reacted at 25 °C for 20 min.

cases, even with a small methyl group adjacent to the carbonyl group (**5c**−**e**), the C−C bond cleavage reaction can proceed smoothly with good regioselectivity and yields. In addition, we also explored the reaction between ADT and these sulfonyl aryl ketones in protic solvent (DMSO/H_2O = 1:1 by volume). As expected,[17] cyclization products are quickly obtained with high yields, which again confirms that the reaction pathway between aryl ketones and ATs is directed by solvent.

To probe the mechanism of this C−C cleavage reaction, we have conducted several control experiments (Scheme 5). First, despite the presence of bulky alkyl groups (**2m** and **n**), the reactions between ADT and alkyl 1,3-diketones offer only diazo transfer products **7m** and **7n** with high yields, which suggests the key role of an aryl group in the ketone for the C−

Scheme 5. Comparison of ADT and TsN_3 on Their Reaction with Ketones with Bulky Substituting Groups[a,b]



[a]Reaction condition: azide **1** (1 mmol, 1.0 equiv), ketone (1 mmol, 1.0 equiv), and K_2CO_3 (0.4 mmol, 0.4 equiv) in DMSO (4 mL) reacted at 25 °C for 15 min. [b]Isolation yields.

C cleavage reaction with ATs, probably the $\pi-\pi$ interaction between the triazine ring in ATs and the aryl rings in aryl ketone. In addition, we also tested the reaction between TsN_3 and aryl 1,3-diketone **2a** and sulfonyl aryl ketone **5a**. Both reactions only offer the diazo transfer products **8a** and **9a**, while no C−C cleavage products were detected.

With these results, we have proposed a mechanism for this C−C cleavage reaction, which is substantiated by DFT calculation. The proposed reaction pathway, the energy profile, and the molecular configurations are depicted in Scheme 6. Taking ADT and 1,3-diketone as examples, the enolates of 1,3-diketones attack the azido group on ADT to afford intermediate **TI 1**. At the absence of protic solvent or acid, the nitride anion in **TI 1** would attack the carbonyl group to form **TI 2**. The regioselectivity is determined by the electrophilicity of the carbonyl groups upon the attack by the nitride anion. Then, **TI 2** undergoes N−N bond cleavage and C−C bond cleavage to produce the final products **3** and **4**. To examine the feasibility of this mechanism, we chose the C−C cleavage reaction between ADT and asymmetric 1,3-diketone **2b** as the model reaction to better demonstrate the regioselectivity. The DFT calculation was performed with the M06-2X/6311+G(d,p) method with D3 dispersion correction in DMSO at 303.15 K. The activation energies were 2.8 kcal/mol for **TI 1** to **TI 2**, 10.8 kcal/mol for **TI 2** to **TI 3**, and 0.1 kcal/mol for **TI 3** to **TI 4** with a final energy release of 31.3 kcal/mol. In **TI 2**, the steric hindrance between t-Bu and a phenyl group provides a large strain on the adjacent C−C, thus reducing the activation energy for cleaving this C−C to 10.8 kcal/mol, making the selective C−C cleavage reaction possible under room temperature without a transition metal catalyst. In addition, in all these intermediates and transition states, the 1,3,5-triazine ring is always perpendicular to the benzene ring, which suggests a possible $\pi-\pi$ interaction between the triazine ring in ADT and the benzene ring in **2b**.

Our recent results have demonstrated that ATs present higher reactivity in solution than most of the other azide reagents.[16] The diazo transfer reaction in aprotic solvents,[16] the C−C cleavage reaction in aprotic solvents, and the cyclization reaction in protic solvents[17] are typically finished in 10 min at room temperature with good yields. However,

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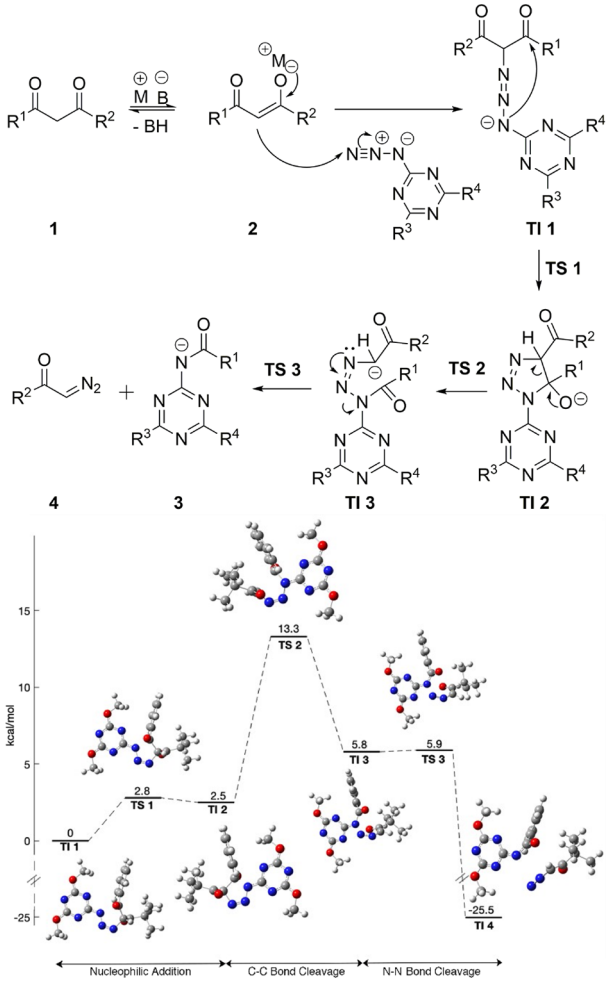
Scheme 6. Postulated Mechanism of C−C Bond Cleavage Reaction and DFT Calculation



despite the low stability of most of the other azide reagents, we have also found that ADT, the most reactive AT in solution, is a highly stable compound in solid state to thermal, impact, and friction tests.[16]

To understand this "stability-reactivity paradox", we obtained the crystalline structure of ADT by X-ray single crystal diffraction (Figure 1a and Table S1). The N−N−N bond angle in the azido group is 171.8°, which diverges from a typical azido group with a linear shape. The DFT calculation of ADT (Figure 1b) also shows a curved azido group. In addition, two infrared (IR) vibration peaks in the 2100−2200 cm^{-1} range were observed for ADT (Figure 1c) and other ATs (Table S2), which indicates that the structure of azido groups in ATs is different from linear azido groups that typically show only one IR vibration peak around 2100 cm^{-1}.[19] Inspired from the studies on the azido-tetrazole isomerism of azido amines,[20] we hypothesize that the interaction between the N on the triazine ring with the azido group may induce the deformation of the azido structure, which alters the delocalized π system in the azido group. Indeed, the two N−N bonds in the azido group show different bond lengths (Figure 1a,b). Thus, this deformed azido group is expected to show a higher reactivity than linear azido groups, which could be the reason for the high reactivity of ATs in solution. On the other hand, Figure 1a also shows that the azido group is in the same plane as the triazine ring, which indicates that the azido group is π-conjugated with the triazine ring. More importantly, the ADT molecules form compact $\pi-\pi$ stacking structure in solid state (Figure 1d). These interactions could help to stabilize ADT in solid state.[16] With these crystal structure, DFT calculation, and IR data, we have provided a feasible explanation of the "stability-reactivity paradox" of ADT, which could be extended to other AT molecules.

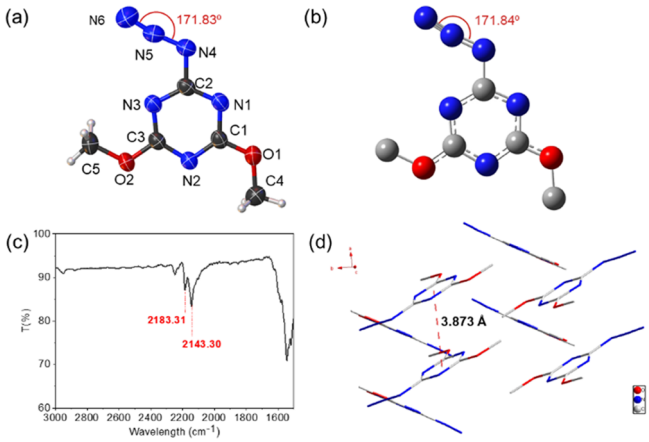


Figure 1. (a) Crystal structure of ADT (ellipsoid contour 50% probability level). (b) Optimized conformation of ADT by DFT calculation. (c) Characteristic IR peaks of the azide group for ADT. (d) Space stacking chart of ADT in a crystal.

CONCLUSIONS

In conclusion, we have developed a novel solvent-directed and regioselective C−C cleavage reaction of aryl ketones with azido triazines. Driven by the steric hindrance in the adducts of aryl ketones and ATs, these C−C cleavage reactions proceed smoothly at mild conditions, without using any transition metal catalyst. We have proposed a feasible mechanism for this C−C cleavage reaction, which is substantiated by DFT calculation. The "stability-reactivity paradox" of ATs can be explained by the deformed azido group that is activated for reactions in solution and the azido-triazine conjugation and π-π stacking structure in solid state, which stabilize ATs in solid state.

EXPERIMENTAL SECTION

General Methods. Reagents involved in experiments were commercially purchased from Sigma-Aldrich and were used as received without further purification for the reactions. Proton nuclear magnetic resonance (^{1}H NMR) and carbon nuclear magnetic resonance (^{13}C NMR) spectroscopy was performed on a Bruker Advance 400M NMR spectrometer. Chemical shifts of ^{1}H NMR spectra are reported as in units of parts per million (ppm) downfield from $SiMe_4$ (0.0) and relative to the signal of chloroform-*d* (J = 7.264, singlet). Multiplicities were given as s (singlet), t (triplet), q (quartet), and m (multiplets). The number of protons (n) for a given resonance is indicated by nH. Coupling constants are reported as a J value in Hz. Carbon nuclear magnetic resonance spectra (^{13}C NMR) are reported as in units of parts per million (ppm) downfield from $SiMe_4$ (0.0) and relative to the signal of chloroform-*d* (J = 77.03, triplet). High-resolution mass spectra (HRMS) were recorded on a Waters Q-Tof Premier spectrometer. Flash column chromatography was performed using ISCO Combiflash RF, and the eluent was a mixture of petroleum ether (PE) and ethyl acetate (EA). A suitable crystal was selected on a SuperNova, Dual, Cu at home/near, AtlasS2 diffractometer. The crystal was kept at 293(2) K during data collection. Using Olex2, the structure was solved with the ShelXT

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structure solution program using Direct Methods and refined with the ShelXL refinement package using Least Squares minimization. The calculation was performed using Gaussian 16 software package. The relative free energies are calculated by the M06-2X/6-311+G(d, p) method with D3 dispersion correction.

General Procedures for the Synthesis of 1,3-Diketones (2a−2h). To a suspension of ketone (5 mmol, 1.0 equiv) in THF (20 mL) was added NaH (10 mmol, 2 equiv) under a N_2 atmosphere. After the reaction mixture was stirred at 0 °C for about 1 h, the ester (5.05 mmol, 1.01 equiv) was added dropwise at the same temperature. Then, the mixture was stirred at 70 °C in an oil bath until TLC indicated the total consumption of the ketone. The reaction mixture was poured into ice-water (100 mL), acidified with aqueous HCl (3 M) to pH 2−3, and extracted with EtOAc (100 mL × 3). The combined organic layer was dried over Na_2SO_4 and evaporated under reduced pressure to provide the crude product. The residue was purified by flash column chromatography on silica gel (EA/PE) to afford desired compound **2**.

*1,3-Diphenylpropane-1,3-dione (**2a**).* The product (0.67 g, 60%) was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.00 (d, J = 8.7 Hz, 4H), 7.56 (t, J = 7.3 Hz, 2H), 7.50 (t, J = 7.4 Hz, 4H), 6.87 (s, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 185.9, 135.6, 132.6, 128.8, 127.3, 93.3. HRMS-ESI (m/z) calculated for $C_{15}H_{12}NaO_2^+$ [M + Na]$^+$, 247.0730; found, 247.0726.

*4,4-Dimethyl-1-phenylpentane-1,3-dione (**2b**).* The product (0.71 g, 70%) was a brown oil. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.89 (d, J = 8.5 Hz, 2H), 7.52 (t, J = 7.3 Hz, 1H), 7.48−7.41 (m, 2H), 6.31 (s, 1H), 1.26 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 203.0, 184.7, 135.6, 132.3, 128.7, 127.1, 92.2, 40.0, 27.5. HRMS-ESI (m/z) calculated for $C_{13}H_{16}NaO_2^+$ [M + Na]$^+$, 227.1043; found, 227.1050.

*1-(4-Methoxyphenyl)-3-phenylpropane-1,3-dione (**2c**).* The product (0.93 g, 73%) was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.97 (m, 4H), 7.52 (m, 3H), 7.00 (d, J = 9.0 Hz, 2H), 6.80 (s, 1H), 3.89 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 186.3, 184.1, 163.4, 135.6, 132.3, 129.4, 128.8, 128.3, 127.1, 114.1, 92.5, 55.6. HRMS-ESI (m/z) calculated for $C_{16}H_{14}NaO_3^+$ [M + Na]$^+$, 277.0835; found, 277.0840.

*1-(Furan-2-yl)-3-phenylpropane-1,3-dione (**2d**).* The product (0.80 g, 75%) was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.96 (d, J = 7.0 Hz, 2H), 7.61 (s, 1H), 7.54 (s, 1H), 7.49−7.44 (m, 2H), 7.27−7.22 (m, 1H), 6.77 (s, 1H), 6.61−6.56 (m, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 183.2, 180.8, 142.4, 134.5, 132.8, 132.4, 130.5, 128.8, 128.5, 126.9, 93.2. HRMS-ESI (m/z) calculated for $C_{13}H_{10}NaO_3^+$ [M + Na]$^+$, 237.0522; found, 237.0528.

*1-Phenyl-3-(thiophen-2-yl)propane-1,3-dione (**2e**).* The product (0.84 g, 73%) was a yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.95 (d, J = 8.3 Hz, 2H), 7.81 (d, J = 5.0 Hz, 1H), 7.64 (d, J = 6.1 Hz, 1H), 7.54 (d, J = 7.3 Hz, 1H), 7.48 (t, J = 7.6 Hz, 2H), 7.19−7.15 (m, 1H), 6.69 (s, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 183.2, 180.8, 142.4, 134.5, 132.8, 132.4, 130.5, 128.8, 128.5, 126.9, 93.2. HRMS-ESI (m/z) calculated for $C_{13}H_{10}NaO_2S^+$ [M + Na]$^+$, 253.0294; found, 253.0299.

*4-(3-Oxo-3-phenylpropanoyl)benzonitrile (**2f**).* The product (0.87 g, 70%) was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.08 (s, 2H), 7.99 (s, 2H), 7.80 (s, 2H), 7.60 (s, 1H), 7.52 (s, 2H), 6.86 (s, 1H). ^{13}C NMR{^{1}H} (101 MHz, chloroform-*d*): δ 187.7, 182.3, 139.4, 135.2, 133.2, 132.6, 129.0, 127.7, 127.5, 118.3, 115.6, 94.0. HRMS-ESI (m/z) calculated for $C_{16}H_{11}NNaO_2^+$ [M + Na]$^+$, 272.0682; found, 272.0689.

*1-(4-Bromophenyl)-3-phenylpropane-1,3-dione (**2g**).* The product (1.06 g, 80%) was a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.98 (s, 2H), 7.86 (d, J = 8.8 Hz, 2H), 7.64 (s, 2H), 7.57 (s, 1H), 7.52 (s, 2H), 6.82 (s, 1H). ^{13}C NMR{^{1}H} (101 MHz, chloroform-*d*): δ 186.0, 184.7, 135.4, 134.5, 132.8, 132.1, 128.9, 128.8, 127.4, 127.3, 93.1. HRMS-ESI (m/z) calculated for $C_{15}H_{11}BrNaO_2^+$ [M + Na]$^+$, 324.9835; found, 324.9843.

*1-Phenyl-3-(pyridin-2-yl)propane-1,3-dione (**2h**).* The product (0.70 g, 62%) was a light brown solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.73−8.68 (m, 1H), 8.18−8.13 (m, 1H), 8.07 (d, J = 8.3 Hz, 2H), 7.85 (t, J = 7.7 Hz, 1H), 7.59−7.53 (m, 2H), 7.49 (d, J = 7.7 Hz, 2H), 7.45−7.40 (m, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 186.4, 183.8, 152.6, 149.4, 137.1, 135.4, 132.8, 128.7, 127.6, 126.5, 122.2, 93.6. HRMS-ESI (m/z) calculated for $C_{14}H_{11}NNaO_2^+$ [M + Na]$^+$, 248.0682; found, 248.0691.

For the preparation steps of compounds **1a−1f**, refer to ref 17.

Preparation of 2-Azido-4,6-dimethoxy-1,3,5-triazine (1a). 2-Chloro-4,6-dimethoxy-1,3,5-triazine (0.76 g, 4.3 mmol, 1.0 equiv) and 5 mL of acetonitrile were introduced to a round-bottom flask equipped with a magnetic stirring bar. Sodium azide solution (4.7 mmol, 1.1 equiv NaN_3 in 2 mL H_2O) was added to the stirring above-mentioned solution. Then, the reaction mixture was stirred at 35 °C in a water bath for 2 h. The reaction mixture was concentrated in vacuum. Then, the mixture was extracted with DCM and H_2O. The combined organic extracts were washed with brine (10 mL), dried over Na_2SO_4, and concentrated in vacuum to provide product **1a** (0.76 g, 97% yield) as a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 4.01 (s, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.3, 172.2, 55.7.

Preparation of Methyl 2-((4-Azido-6-methoxy-1,3,5-triazin-2-yl)oxy)acetate (1b). 2,4-Dichloro-6-methoxy-1,3,5-triazine (2.5 g, 14 mmol, 1.0 equiv) was dissolved in MeCN (100 mL) and stirred in an ice-water bath. Then, the solution of sodium azide (1.0 g, 15.4 mmol, 1.1 equiv) in 5 mL of H_2O was added. The reaction mixture was stirred for 2 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 25 mL). The combined organic phase was washed with brine (30 mL), dried over Na_2SO_4, and concentrated in vacuum to provide product 2-azido-4-chloro-6-methoxy-1,3,5-triazine (2.40 g, 93%), without further purification.

To a solution of 2-azido-4-chloro-6-methoxy-1,3,5-triazine (1.0 g, 5.4 mmol, 1.0 equiv) in 20 mL of MeCN were added methyl glycolate (0.58 g, 6.5 mmol, 1.2 equiv) and 1 mL of *N*,*N*-diisopropylethylamine (DIEA). The reaction mixture was stirred at 50 °C in an oil bath for 6 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 10 mL). The combined organic phase was washed with brine (15 mL), dried over Na_2SO_4, and concentrated in vacuum; it was further purified by flash column chromatography on a silica gel column (PE/EA = 2.5:1 v/v) to provide product **1b** (1.14 g, 88%) as a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 4.95 (d, J = 10.4 Hz, 2H), 4.03 (d, J = 10.3 Hz, 3H), 3.77 (d, J = 3.6 Hz, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.3, 172.4, 172.4, 167.8, 64.0, 55.9, 52.5.

Preparation of Methyl (4-Azido-6-methoxy-1,3,5-triazin-2-yl) Glycinate (1c). To a solution of 2-azido-4-chloro-6-methoxy-1,3,5-triazine (1.0 g, 5.4 mmol, 1.0 equiv) in 20 mL of MeCN were added methyl glycinate (0.57 g, 6.5 mmol, 1.2 equiv) and 1 mL of *N*,*N*-diisopropylethylamine (DIEA). The reaction mixture was stirred at 70 °C in an oil bath for 3 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 10 mL). The combined organic phase was washed with brine (15 mL), dried over Na_2SO_4, and concentrated in vacuum; it was further purified by flash column chromatography on a silica gel column (PE/EA = 2.5:1 v/v) to provide product **1c** (1.16 g, 90%) as a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 6.63 (d, J = 98.1 Hz, 1H), 4.23 (s, 2H), 3.94 (s, 3H), 3.77 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 171.9, 171.7, 170.9, 170.4, 170.2, 170.1, 167.7, 167.6, 55.1, 52.6, 42.7.

Preparation of Dimethyl 2,2′-((6-Azido-1,3,5-triazine-2,4-diyl)bis(oxy))diacetate (1d). To an ice bath-cooled solution of cyanuric chloride (1.00 g, 5.4 mmol, 1.0 equiv) in MeCN (30 mL) were added methyl glycolate (1.17 g, 13 mmol, 2.4 equiv) and 2 mL of *N*,*N*-diisopropylethylamine (DIEA). The reaction mixture was continuously stirred for 1 h; then, it was heated to 50 °C in an oil bath and stirred for another 3.0 h. The reaction mixture was concentrated in vacuum, and the residue was poured into water, which was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic phase was washed with brine (20 mL), dried over Na_2SO_4, and concentrated

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in vacuum to provide product dimethyl 2,2′-((6-chloro-1,3,5-triazine-2,4-diyl)bis(oxy))diacetate (1.4 g, 88%), without further purification.

Dimethyl 2,2′-((6-chloro-1,3,5-triazine-2,4-diyl)bis(oxy))diacetate (1.0 g, 3.4 mmol, 1.0 equiv) was dissolved in MeCN (20 mL) and stirred in an ice-water bath. Then, the solution of sodium azide (0.25 g, 3.8 mmol, 1.1equiv) in 2 mL of H_2O was added. The reaction mixture was stirred at 35 °C in a water bath for 2 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 15 mL). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and concentrated in vacuum; it was further purified by flash column chromatography on a silica gel column (PE/EA = 2:1 v/v) to provide product **1d** (0.91 g, 90%) as a yellow oil. ^{1}H NMR (400 MHz, chloroform-*d*): δ 4.91 (s, 4H), 3.76 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 172.5172.4, 167.6, 64.1, 52.6.

Preparation of Methyl 2-((4-Azido-6-methoxy-1,3,5-triazin-2-yl)thio)acetate (1e). To a solution of 2-azido-4-chloro-6-methoxy-1,3,5-triazine (1.0 g, 5.4 mmol, 1.0 equiv) in 20 mL of MeCN were added methyl thioglycolate (0.64 g, 6 mmol, 1.1 equiv) and 1 mL of *N*,*N*-diisopropylethylamine (DIEA). The reaction mixture was stirred at room temperature for 4 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 10 mL). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and concentrated in vacuum; it was further purified by flash column chromatography on a silica gel column (PE/EA = 2.5:1 v/v) to provide product **1e** (1.18 g, 85%) as a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 4.01 (s, 3H), 3.90 (s, 2H), 3.75 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 183.8, 170.6, 170.0, 168.9, 55.8, 53.0, 32.9.

Preparation of Dimethyl 2,2′-((6-Azido-1,3,5-triazine-2,4-diyl)bis(sulfanediyl))diacetate (1f). To an ice bath-cooled solution of cyanuric chloride (1.00 g, 5.4 mmol, 1.0 equiv) in MeCN (30 mL) were added methyl thioglycolate (1.28 g, 12 mmol, 2.2 equiv) and 2 mL of *N*,*N*-diisopropylethylamine (DIEA). The reaction mixture was continuously stirred for 1 h and stirred at room temperature for another 3.0 h. The reaction mixture was concentrated in vacuum, and the residue was poured into water, which was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic phase was washed with brine (20 mL), dried over Na_2SO_4, and concentrated in vacuum to provide product dimethyl 2,2′-((6-chloro-1,3,5-triazine-2,4-diyl)bis(sulfanediyl))diacetate (1.52 g, 87%).

Dimethyl 2,2′-((6-chloro-1,3,5-triazine-2,4-diyl)bis(sulfanediyl))diacetate (1.0 g, 3.1 mmol, 1.0 equiv) was dissolved in MeCN (20 mL) and stirred in an ice-water bath. Then, the solution of sodium azide (0.23 g, 3.5 mmol, 1.1 equiv) in 2 mL of H_2O was added. The reaction mixture was stirred at 35 °C in a water bath for 2 h and then concentrated in vacuum. The residue was poured into water, which was extracted with CH_2Cl_2 (3 × 15 mL). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and concentrated in vacuum; it was further purified by flash column chromatography on a silica gel column (PE/EA = 2:1 v/v) to provide product **1f** (0.96 g, 94%) as a white solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 3.88 (s, 4H), 3.76 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 181.4, 168.8, 167.1, 53.1, 32.7.

General Procedures for the Carbon−Carbon Bond Cleavage Reaction. To a solution of active methylene compounds (1 mmol, 1.0 equiv) in DMSO (4 mL) was added K_2CO_3 (0.4 mmol, 0.4 equiv) and stirred at 25 °C for 3−5 min. Then, azide **1** (1 mmol, 1.0 equiv) was added in one portion. The reaction mixture was stirred and monitored by TLC. After completion, the reaction mixture was poured into water (10 mL) and extracted with EtOAc (10 mL × 3). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and evaporated under reduced pressure to provide the crude product. The residue was purified by flash column chromatography on silica gel (EA/PE) to afford the desired compound.

*N-(4,6-Dimethoxy-1,3,5-triazin-2-yl)benzamide (**3a**).* The product (182 mg, 71%) was a white solid, with petroleum ether/EtOAc as the eluent (PE/EA = 4:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.67 (s, 1 H), 7.90 (d, *J* = 8 Hz, 2 H), 7.60 (m, 1 H), 7.54 (m, 2 H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.2, 166.2, 164.9, 133.8, 133.0, 129.0, 127.8, 55.7. HRMS-ESI (*m*/*z*) calculated for $C_{12}H_{12}N_4NaO_3^+$ [M + Na]$^+$, 283.0802; found, 283.0811.

*4-Cyano-N-(4,6-dimethoxy-1,3,5-triazin-2-yl)benzamide (**3f**).* The product (145 mg, 51%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2.5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.62 (s, 1H), 8.01−7.95 (m, 2H), 7.84−7.78 (m, 2H), 4.02 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.1, 165.9, 163.77, 137.7, 132.8, 128.5, 117.8, 116.3, 55.6. HRMS-ESI (*m*/*z*) calculated for $C_{13}H_{11}N_5NaO_3^+$ [M + Na]$^+$, 308.0754; found, 308.0766.

*4-Bromo-N-(4,6-dimethoxy-1,3,5-triazin-2-yl)benzamide (**3g**).* The product (129 mg, 38%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2.5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.45 (s, 1H), 7.76 (d, *J* = 8.5 Hz, 2H), 7.65 (d, *J* = 8.4 Hz, 2H), 4.04 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.0, 166.1, 164.3, 132.6, 132.2, 129.4, 127.9, 55.4. HRMS-ESI (*m*/*z*) calculated for $C_{12}H_{11}BrN_4NaO_3^+$ [M + Na]$^+$, 360.9907; found, 360.9912.

*N-(4,6-Dimethoxy-1,3,5-triazin-2-yl)picolinamide (**3h**).* The product (160 mg, 61%) was a brown solid, with petroleum ether/EtOAc as the eluent (PE/EA = 3:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 10.67 (s, 1H), 8.64 (d, *J* = 4.3 Hz, 1H), 8.31 (d, *J* = 7.8 Hz, 1H), 7.92 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.56−7.52 (m, 1H), 4.08 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.2, 165.6, 161.7, 148.5, 148.3, 137.9, 127.5, 123.1, 55.4. HRMS-ESI (*m*/*z*) calculated for $C_{11}H_{11}N_5NaO_3^+$ [M + Na]$^+$, 284.0754; found, 284.0760.

*N-(4,6-Dimethoxy-1,3,5-triazin-2-yl)-2,2,2-trifluoroacetamide (**3i**).* The product (76 mg, 30%) was a light yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 3:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.89 (s, 1H), 4.06 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.2, 170.6, 164.8, 116.4, 55.9. HRMS-ESI (*m*/*z*) calculated for $C_7H_7F_3N_4NaO_3^+$ [M + Na]$^+$, 275.0362; found, 275.0375.

*2-Diazo-1-phenylbutane-1,3-dione (**3j′**).* The product (167 mg, 89%) was a white solid, with petroleum ether/EtOAc as the eluent (PE/EA = 5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.67−7.62 (m, 2H), 7.61−7.56 (m, 1H), 7.52−7.48 (m, 2H), 2.58 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 190.9, 185.1, 137.3, 132.7, 128.9, 127.4, 29.3.

*Ethyl 2-Diazo-3-oxo-3-phenylpropanoate (**3k′**).* The product (190 mg, 87%) was a light yellow liquid, with petroleum ether/EtOAc as the eluent (PE/EA = 5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.63 (d, *J* = 7.0 Hz, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.5 Hz, 2H), 4.25 (q, *J* = 7.1 Hz, 2H), 1.26 (t, *J* = 7.1 Hz, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 186.9, 161.0, 137.1, 132.3, 128.4, 127.9, 61.6, 14.2.

*Ethyl 2-Diazo-3-(4-nitrophenyl)-3-oxopropanoate (**3l′**).* The product (210 mg, 80%) was a light yellow liquid, with petroleum ether/EtOAc as the eluent (PE/EA = 5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.34−8.21 (m, 2H), 7.80−7.68 (m, 2H), 4.25 (q, *J* = 7.1 Hz, 2H), 1.27 (t, *J* = 7.1 Hz, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 185.6, 160.4, 149.6, 142.5, 129.3, 123.1, 62.0, 14.2.

*N-(4,6-Dimethoxy-1,3,5-triazin-2-yl)acetamide (**3m**).* The product was a light yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 3:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.21 (s, 1H), 4.00 (s, 6H), 2.58 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 172.9, 171.7, 165.7, 55.5, 25.9. HRMS-ESI (*m*/*z*) calculated for $C_7H_{10}N_4NaO_3^+$ [M + Na]$^+$, 221.0645; found, 221.0649.

*Methyl 2-((4-Benzamido-6-methoxy-1,3,5-triazin-2-yl)oxy) acetate (**3ab**).* The product (149 mg, 47%) was a light yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.48 (s, 1H), 7.90−7.85 (m, 2H), 7.63−7.58 (m, 1H), 7.51 (t, *J* = 7.6 Hz, 2H), 4.97 (s, 2H), 4.03 (s, 3H), 3.79 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.1, 172.2, 168.1, 166.1, 164.8, 133.7, 133.0, 129.0, 127.8, 63.9, 55.6, 52.4. HRMS-ESI (*m*/*z*) calculated for $C_{14}H_{14}N_4NaO_5^+$ [M + Na]$^+$, 341.0856; found, 341.0864.

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*Methyl (4-Benzamido-6-methoxy-1,3,5-triazin-2-yl)glycinate (**3ac**).* The product (264 mg, 83%) was an orange solid, with petroleum ether/EtOAc as the eluent (PE/EA = 1:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.56 (s, 1H), 7.86 (d, J = 8.4 Hz, 2H), 7.57 (t, J = 7.4 Hz, 1H), 7.48 (t, J = 7.6 Hz, 2H), 6.54 (s, 1H), 4.25 (d, J = 5.5 Hz, 2H), 3.92 (d, J = 2.6 Hz, 3H), 3.77 (d, J = 5.4 Hz, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 171.3, 170.3, 167.8, 166.2, 164.7, 134.2, 132.6, 128.8, 127.8, 54.7, 52.4, 42.9. HRMS-ESI (m/z) calculated for $C_{14}H_{15}N_5NaO_4^+$ [M + Na]$^+$, 340.1016; found, 340.1023.

*Dimethyl 2,2′-((6-Benzamido-1,3,5-triazine-2,4-diyl)bis(oxy)) diacetate (**3ad**).* The product (154 mg, 41%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.69 (s, 1H), 7.87 (d, J = 8.6 Hz, 2H), 7.59 (t, J = 7.4 Hz, 1H), 7.49 (t, J = 7.6 Hz, 2H), 4.93 (s, 4H), 3.78 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 172.1, 167.9, 166.2, 164.8, 133.5, 132.9, 128.8, 127.8, 63.8, 52.4. HRMS-ESI (m/z) calculated for $C_{16}H_{16}N_4NaO_7^+$ [M + Na]$^+$, 399.0911; found, 399.0919.

*Methyl 2-((4-Benzamido-6-methoxy-1,3,5-triazin-2-yl)thio) Acetate (**3ae**).* The product (160 mg, 48%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.41 (s, 1H), 7.90−7.85 (m, 2H), 7.61 (t, J = 7.4 Hz, 1H), 7.51 (t, J = 7.6 Hz, 2H), 4.02 (s, 3H), 3.96 (s, 2H), 3.77 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 183.2, 170.3, 169.1, 164.8, 163.7, 133.6, 133.1, 129.0, 127.8, 55.5, 53.0, 32.8. HRMS-ESI (m/z) calculated for $C_{14}H_{14}N_4NaO_4S^+$ [M + Na]$^+$, 357.0628; found, 357.0634.

*Dimethyl 2,2′-((6-Benzamido-1,3,5-triazine-2,4-diyl)bis-(sulfanediyl))diacetate (**3af**).* The product (118 mg, 29%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 2.5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.37 (s, 1H), 7.86 (d, J = 8.6 Hz, 2H), 7.60 (d, J = 7.4 Hz, 1H), 7.51 (t, J = 7.6 Hz, 2H), 3.94 (s, 4H), 3.78 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 180.8, 169.0, 164.6, 160.7, 133.5, 133.2, 129.1, 127.8, 53.0, 32.7. HRMS-ESI (m/z) calculated for $C_{16}H_{16}N_4NaO_5S_2^+$ [M + Na]$^+$, 431.0454; found, 431.0463.

*2-Diazo-1-phenylethan-1-one (**4a**).* The product was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 9:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.75 (d, J = 7.3 Hz, 2H), 7.53 (t, J = 7.4 Hz, 1H), 7.43 (t, J = 7.6 Hz, 2H), 5.91 (s, 1H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 186.4, 136.7, 132.8, 128.7, 126.8, 54.3.

General Procedures for the Synthesis of Triazine Compounds (6a−6e). To a solution of active methylene compounds **5** (1 mmol, 1.0 equiv) (were commercially purchased from Sigma-Aldrich) in DMSO/H_2O (4 mL, v:v = 1:1) was added K_2CO_3 (0.4 mmol, 0.4 equiv) and stirred at 25 °C for 3−5 min. Then, azide **1** (1 mmol, 1.0 equiv) was added in one portion. The reaction mixture was stirred and monitored by TLC. After completion, the reaction mixture was poured into water (10 mL) and extracted with EtOAc (10 mL × 3). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and evaporated under reduced pressure to provide the crude product. The residue was purified by flash column chromatography on silica gel (EA/PE) to afford the desired compound if necessary.

*2,4-Dimethoxy-6-(5-phenyl-4-(phenylsulfonyl)-1H-1,2,3-triazol-1-yl)-1,3,5-triazine (**6a**).* The product was a light yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 4:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.79 (dd, J = 8.4, 1.2 Hz, 2H), 7.60−7.55 (m, 1H), 7.53−7.49 (m, 1H), 7.46−7.41 (m, 4H), 7.29 (dd, J = 7.6, 1.9 Hz, 2H), 3.75 (s, 6H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.4, 163.9, 147.0, 140.3, 140.3, 134.1, 130.4, 130.0, 129.3, 128.4, 128.2, 125.5, 56.2. HRMS-ESI (m/z) calculated for $C_{19}H_{16}N_6NaO_4S^+$ [M + Na]$^+$, 447.0846; found, 447.0840.

*2,4-Dimethoxy-6-(5-phenyl-4-tosyl-1H-1,2,3-triazol-1-yl)-1,3,5-triazine (**6b**).* ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.68 (d, J = 8.1 Hz, 2H), 7.51 (d, J = 7.5 Hz, 1H), 7.46 (d, J = 7.4 Hz, 2H), 7.31 (d, J = 7.3 Hz, 2H), 7.24 (d, J = 8.0 Hz, 2H), 3.76 (s, 6H), 2.40 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.3, 163.9, 147.2, 145.3, 140.0, 137.3, 130.4, 130.0, 129.9, 128.4, 128.3, 125.5, 56.2, 21.8. HRMS-ESI (m/z) calculated for $C_{20}H_{18}N_8NaO_4S^+$ [M + Na]$^+$, 461.1002; found, 461.1010.

*2,4-Dimethoxy-6-(5-methyl-4-(phenylsulfonyl)-1H-1,2,3-triazol-1-yl)-1,3,5-triazine (**6c**).* The product was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.08 (d, J = 7.5 Hz, 2H), 7.62 (t, J = 7.4 Hz, 1H), 7.54 (t, J = 7.6 Hz, 2H), 4.13 (s, 6H), 3.00 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.5, 164.4, 145.9, 140.6, 139.1, 134.1, 129.5, 128.0, 56.5, 11.6. HRMS-ESI (m/z) calculated for $C_{14}H_{14}N_6NaO_4S^+$ [M + Na]$^+$, 385.0689; found, 385.0693.

*2,4-Dimethoxy-6-(5-methyl-4-tosyl-1H-1,2,3-triazol-1-yl)-1,3,5-triazine (**6d**).* The product was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.95 (d, J = 8.3 Hz, 2H), 7.33 (d, J = 8.2 Hz, 2H), 4.13 (s, 6H), 2.99 (s, 3H), 2.41 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.5, 164.4, 146.2, 145.3, 138.8, 137.7130.1, 128.1, 56.5, 21.8, 11.5. HRMS-ESI (m/z) calculated for $C_{15}H_{16}N_6NaO_4S^+$ [M + Na]$^+$, 399.0846; found, 399.0839.

*2-(4-((4-Chlorophenyl)sulfonyl)-5-methyl-1H-1,2,3-triazol-1-yl)-4,6-dimethoxy-1,3,5-triazine (**6e**).* The product was a light yellow solid. ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.01 (d, J = 8.1 Hz, 2H), 7.52 (d, J = 8.1 Hz, 2H), 4.13 (s, 6H), 3.00 (s, 3H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 173.5, 164.4, 145.5, 140.9, 139.2, 139.0, 129.8, 129.6, 56.5, 11.6. HRMS-ESI (m/z) calculated for $C_{14}H_{13}ClN_6NaO_4S^+$ [M + Na]$^+$, 419.0300; found, 419.0306.

General Procedures for the Synthesis of Diazo Compounds (7m, 7n, 8a, and 9a). To a solution of active methylene compounds (1 mmol, 1.0 equiv) in DMSO (4 mL) was added K_2CO_3 (0.4 mmol, 0.4 equiv) and stirred at 25 °C for 3−5 min. Then, azide (1 mmol, 1.0 equiv) was added in one portion. The reaction mixture was stirred and monitored by TLC. After 15 min, the reaction mixture was poured into water (10 mL) and extracted with EtOAc (10 mL × 3). The combined organic phase was washed with brine (10 mL), dried over Na_2SO_4, and evaporated under reduced pressure to provide the crude product. The residue was purified by flash column chromatography on silica gel (EA/PE) to afford the desired compound if necessary.

*4-Diazo-2,6-dimethylheptane-3,5-dione (**7m**).* The product (173 mg, 95%) was a pale yellow liquid, with petroleum ether/EtOAc as the eluent (PE/EA = 19:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 3.24 (hept, J = 6.8 Hz, 2H), 1.14 (d, J = 6.8 Hz, 12H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 195.6, 81.5, 38.1, 18.6.

*4-Diazo-2,2,6,6-tetramethylheptane-3,5-dione (**7n**).* The product (180 mg, 86%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 19:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 1.27 (s, 18H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 97.1, 80.1, 45.4, 26.7.

*2-Diazo-1,3-diphenylpropane-1,3-dione (**8a**).* The product (238 mg, 95%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 7.59−7.54 (m, 4H), 7.44 (t, J = 7.5 Hz, 2H), 7.35−7.29 (m, 4H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 186.6, 137.1, 132.8, 128.5, 128.5, 84.6.

*2-Diazo-1-phenyl-2-(phenylsulfonyl)ethan-1-one (**9a**).* The product (248 mg, 87%) was a yellow solid, with petroleum ether/EtOAc as the eluent (PE/EA = 5:1 v/v). ^{1}H NMR (400 MHz, chloroform-*d*): δ 8.06 (dd, J = 8.4, 1.2 Hz, 2H), 7.69−7.64 (m, 1H), 7.56 (ddd, J = 6.0, 4.2, 3.0 Hz, 5H), 7.47−7.42 (m, 2H). ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*): δ 182.7, 141.5, 135.9, 134.3, 133.2, 129.3, 129.0, 128.3, 127.6, 83.5.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.joc.0c02342.

Calculation details, characterization data, X-ray crystallography data of **1a**, and ^{1}H and ^{13}C NMR spectra of new compounds (PDF)

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CCDC 2031339 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif, or by emailing data_request@ccdc.cam.ac.uk, or by contacting The Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK; fax: +44 1223 336033.

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Notes

The authors declare no competing financial interest.

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