Supplementary Information

Ultra-Fast Suzuki and Heck Reactions for the Synthesis of Styrenes and Stilbenes Using Arenediazonium Salts as Super-Electrophiles

Marina E. Trusova¹, Mireia Rodríguez-Zubiri², Ksenia V. Kutonova¹,³, Nicole Jung,³,⁴ Stefan Bräse,³,⁴ François-Xavier Felpin²,⁵*, Pavel S. Postnikov⁶*

¹ Department of Biotechnology and Organic Chemistry, Tomsk Polytechnic University, Tomsk, 634050, Russia
² Université de Nantes, UFR des Sciences et des Techniques, CNRS UMR 6230, CEISAM, 2 rue de la Houssinière, 44322 Nantes Cedex 3, France. E-mail: fx.felpin@univ-nantes.fr
³ Institute of Organic Chemistry, Karlsruhe Institute of Technology (KIT), Fritz-Haber-Weg 6, 76131 Karlsruhe, Germany
⁴ Institute of Toxicology and Genetics, Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany
⁵ Institut Universitaire de France, 1 rue Descartes, 75231 Paris Cedex 05, France
⁶ Department of Technology of Organic Substrates and Polymer Materials, Tomsk Polytechnic University, Tomsk, 634050, Russia. E-mail: postnikov@tpu.ru

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**General experimental remarks**

$^1$H NMR spectra were recorded on BRUKER AM 400 (400 MHz) and BRUKER AM 300 (300 MHz) spectrometers. Chemical shifts are given in parts per million ($\delta$/ppm), referenced to dimethylsulfoxide (2.51) as internal standards. All coupling constants are absolute values and are expressed in Hertz (Hz). The description of signals include: s = singlet, d = doublet, t = triplet, dd = doublet of doublets, dt doublet of triplets, m = multiplet. $^{13}$C NMR spectra were recorded on Bruker AM 400 (100 MHz) and BRUKER AM 300 (300 MHz) spectrometers. High Resolution mass-spectra were recorded on XEVO G2-XS OTOF from WATERS with ESI ionization (column Zorbax Eclipse Plus C18 Rapid Resolution HD 2.1x50mm 1.8-Micron).

Routine monitoring of reactions were performed using silica gel coated aluminium plates (Merck, silica gel 60, F254) which were analyzed under UV-light at 254 nm and dipped into a solution of 2-naphthol (5 % naphthol in 10 % NaOH aqueous, dipping solution). Solvent mixtures are understood as volume/volume. Solvents, reagents and chemicals were purchased from Sigma/Aldrich. Solvents, reagents and chemicals were used as purchased unless stated otherwise.

1. General Procedure for Preparation of styrenes from vinyl-BF$_3$K and ADT. To a mixture of ADT (2a-m) (0.2 mmol) and potassium vinyltrifluoroborate (0.3 mmol, 0.0402 g) in 5 ml water/acetonitrile (1/1) was added 1 mol % Pd(OAc)$_2$ (0.002 mmol, 0.0005 g). The end of the nitrogen evolution and the formation of Pd(0) indicated the reaction completion. Brine (10 ml) was added to the reaction mixture and the organic layer was extracted with pentane (3×50 mL). The organic layers were dried over anhydrous MgSO$_4$. The solvent was removed in vacuo to give the corresponding styrene without further purification (3a-m).

1-nitro-4-vinylbenzene (3a). According to the general procedure, the reaction of 4-nitrobenzenediazonium tosylate (0.3 mmol, 0.040 g) for 25 sec afforded compound 3a (0.03 g, 97 % yield) as a yellow oil.$^1$ $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.18 (d, $J = 10.8$ Hz, 2H), 7.53 (d, $J = 8.4$ Hz, 2H), 6.81-6.74 (dd, $J = 17.6$, 10.8 Hz, 1H), 5.93 (d, $J = 17.6$ Hz, 1H), 5.49 (d, $J = 10.8$ Hz, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 147.1; 143.8; 135.0; 126.8; 124.0; 118.7.

4-vinylbenzonitrile (3b). According to the general procedure, the reaction of 4-cyanobenzenediazonium tosylate (0.3 mmol, 0.040 g) for 20 sec afforded compound 3b (0.023 g, 90% yield) as a yellow oil.$^1$ $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 7.61 (d, $J = 8.7$ Hz, 2H), 7.48 (d, $J = 8.7$ Hz, 2H), 6.77-6.68 (dd, $J = 17.7$, 11.1, 10.8 Hz, 1H), 5.87 (d, $J = 17.4$ Hz, 1H), 5.45 (d, $J = 10.8$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 142.0; 133.5; 132.5; 126.9; 119.0; 117.9; 111.2.

4-vinylbenzoic acid (3c). According to the general procedure, the reaction of 4-carboxybenzenediazonium tosylate (0.3 mmol, 0.040 g) for 35 sec afforded compound 3c (0.028 g, 94 % yield) as a brown solid. mp = 141-142 °C [lit. 143-144 °C.$^2$] $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.08 (d, $J = 8.4$ Hz, 2H), 7.50 (d, $J = 8.0$ Hz, 2H), 6.81-6.74 (dd, $J = 17.6$, 11.2 Hz, 1H), 5.91 (d, $J = 17.6$ Hz, 1H), 5.43 (d, $J = 10.8$ Hz, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 172.3; 142.9; 136.1; 130.7; 128.5; 126.4; 117.2.

1-bromo-4-vinylbenzene (3d). According to the general procedure, the reaction of 4-bromobenzenediazonium tosylate (0.3 mmol, 0.040 g) for 30 sec afforded compound 3d (0.030 g, 83 % yield) as a yellow oil.$^3$ $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.45 (d, $J = 8.8$ Hz, 2H), 7.28 (d, $J = 8.8$ Hz, 2H), 6.69-6.62 (dd, $J = 17.6$, 10.8 Hz, 1H), 5.75 (d, $J = 17.6$ Hz, 1H), 5.29 (d, $J = 10.8$ Hz, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 136.7; 135.8; 131.7; 128.0; 121.9; 114.6.

4-vinylaniline (3e). According to the general procedure, the reaction of 4-aminobenzenediazonium tosylate (0.3 mmol, 0.040 g) and AcONa (0.2 mmol, 0.027 g) for 20 sec afforded compound 3e (0.012 g, 52% yield) as a yellow oil.$^4$ $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 7.25 (d, $J = 8.7$ Hz, 2H), 6.71-6.57...
(m, 3H), 5.56 (d, J = 17.7 Hz, 1H), 5.06 (d, J = 10.5 Hz, 1H); 13C NMR (75 MHz, CDCl3): δ 146.3; 136.7; 127.5; 115.4; 113.3; 110.4.

4-vinyl-1,1-biphenyl (3f). According to the general procedure, the reaction of 4-phenylbenzenediazonium tosylate 2f (0.2 mmol, 0.070 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 40 sec afforded compound 3f (0.026 g, 72 % yield) as a white solid. mp = 114-116 °C [lit. 115-117 °C].¹ H NMR (400 MHz, CDCl3): δ 7.61-76 (m, 4H), 7.50-7.42 (m, 4H), 7.37-7.33 (m, 1H), 6.80-6.73 (dd, J = 17.6, 10.8 Hz, 1H), 5.80 (d, J = 17.6 Hz, 1H), 5.28 (d, J = 10.8 Hz, 1H); 13C NMR (100 MHz, CDCl3): δ 140.8; 140.7; 136.7; 136.5; 128.9; 127.4; 127.1; 126.7; 114.0.

2-(4-vinylphenyl)benzo[d]thiazole (3g). According to the general procedure, the reaction of 4-(benzo[d]thiazol-2-yl)benzenediazonium tosylate 2g (0.2 mmol, 0.085 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 3.5 h afforded compound 3g (0.037 g, 91 % yield) as an orange solid. mp = 72-74 °C [lit. 74-75 °C.]

(E)-1-phenyl-2-(4-vinylphenyl)diazene (3h). According to the general procedure, the reaction of (E)-4-(phenyl diazene)benzenediazonium tosylate 2h (0.2 mmol, 0.062 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 25 sec afforded compound 3h (0.038 g, 91 % yield) as an orange solid. mp = 72-74 °C [lit. 74-75 °C].¹ H NMR (400 MHz, CDCl3): δ 7.93-7.89 (m, 4H), 7.57-7.47 (m, 5H), 6.83-6.76 (dd, J = 17.6, 11.2, 10.8 Hz, 1H), 5.87 (d, J = 17.6 Hz, 1H), 5.37 (d, J = 11.2 Hz, 1H); 13C NMR (100 MHz, CDCl3): δ 167.8; 154.3; 140.2; 136.2; 135.1; 133.0; 127.9; 126.9; 126.5; 123.3; 121.7; 115.8.

5-vinyluracil (3i). According to the general procedure, the reaction of 5-uracildiazonium tosylate 2i (0.2 mmol, 0.062 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 340 sec afforded compound 3i (0.038 g, 91 % yield) as a white solid mp 107-109 °C.

1-nitro-2-vinylbenzene (3j). According to the general procedure, the reaction of 2-vinylbenzoic acid (3k) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 62 sec afforded compound 3j (0.022 g, 83 % yield) as a yellow oil.º H NMR (400 MHz, CDCl3): δ 7.93-7.89 (m, 4H), 7.57-7.47 (m, 5H), 6.83-6.76 (dd, J = 17.6, 11.2, 10.8 Hz, 1H), 5.40 (d, J = 17.2 Hz, 1H), 5.04 (d, J = 11.6 Hz, 1H); 13C NMR (100 MHz, CDCl3): δ 136.2; 150.6; 140.3; 136.3; 131.1; 129.2; 127.1; 123.4; 123.0; 115.8.

2-vinylbenzoic acid (3k). According to the general procedure, the reaction of 2-carboxybenzenediazonium tosylate 2k (0.2 mmol, 0.064 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 62 sec afforded compound 3k (0.025 g, 83 % yield) as a white solid. mp = 93-95 °C [lit. 93-95 °C].¹ H NMR (400 MHz, CDCl3): δ 8.06 (d, J = 7.6 Hz, 1H), 7.63-7.54 (m, 3H), 7.39-7.36 (m, 1H), 5.68 (d, J = 17.2 Hz, 1H), 5.40 (d, J = 11.2 Hz, 1H); 13C NMR (100 MHz, CDCl3): δ 173.1; 140.8; 136.2; 133.3; 132.6; 128.6; 128.5; 124.6; 119.1.

2-chloro-4-nitro-1-vinylbenzene (3l). According to the general procedure, the reaction of 2-chloro-4-nitrobenzenediazonium tosylate 2l (0.2 mmol, 0.071 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 35 sec afforded compound 3l (0.034 g, 91 % yield) as a white solid mp 111-112 °C [lit. 110-112 °C.¹]. H NMR (400 MHz, CDCl3): δ 7.93 (s, 1H), 7.59-7.53 (m, 2H), 7.15-7.08 (dd, J = 17.6, 11.2, 10.8 Hz, 1H), 5.75 (d, J = 17.2 Hz, 1H), 5.52 (d, J = 10.8 Hz, 1H); 13C NMR (100 MHz, CDCl3): δ 147.6; 133.8; 133.1; 131.3; 127.8; 127.7; 127.2; 117.0.

2,4,6-tribromo-1-vinylbenzene (3m). According to the general procedure, the reaction of 2,4,6-tribromobenzenediazonium tosylate 2m (0.2 mmol, 0.103 g) with potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) for 3.5 h afforded compound 3m (0.037 g, 54 % yield) as a white solid mp 124-127 °C [lit. 123-125 °C.¹]. H NMR (400 MHz, CDCl3): δ 7.72 (s, 2H),
2. General Procedure for preparation of symmetric stilbenes from vinyl-BF$_3$K and ADT. To a mixture of ADT (0.4 mmol) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) in water/acetonitrile (5 mL, 1/1) was added Pd(OAc)$_2$ (1 mol %). The reaction vessel was immediately placed into a microwave reactor (70 °C, 30 bars). After completion, brine was added, the reaction mixture was extracted with CHCl$_3$ (3×50 mL) and dried over anhydrous MgSO$_4$. The solvent was removed in vacuo to give the corresponding stilbenes without further purification.

\textit{(E)-4,4'-dinitrostilbene 4a.} According to the general procedure, the reaction of 4-nitrobenzenediazonium tosylate 2a (0.4 mmol, 0.128 g) with potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) for 56 min afforded compound 4a (0.048 g, 86% yield) as a white solid mp 290 °C (decomp.) [lit. 292-295 °C].$^1$H NMR (400 MHz, DMSO-d$_6$): $\delta$ 8.28 (d, $J$ = 8.8 Hz, 4H), 7.95 (d, $J$ = 8.8 Hz, 4H), 7.70 (s, 2H); $^{13}$C NMR (100 MHz, DMSO-d$_6$): $\delta$ 147.0; 143.2; 131.1; 128.2; 124.3.

\textit{(E)-4,4'-dicyanoestilbene 4b.} According to the general procedure, the reaction of 4-cyanobenzenediazonium tosylate 2b (0.4 mmol, 0.12 g) with potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) for 1 min afforded compound 4b (0.024 g, 51% yield) as a white solid mp 291-293 °C (decomp.) [lit. 294-296 °C].$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.74 (d, $J$ = 8.4 Hz, 2H), 7.75 (d, $J$ = 8 Hz, 2H), 7.32 (s, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 140.8; 132.8; 130.4; 127.4; 118.9; 111.8.

\textit{(E)-4,4'-dibromostilbene 4c.} According to the general procedure, the reaction of 4-brombenzenediazonium tosylate 2d (0.4 mmol, 0.142 g) with potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) for 9 min afforded compound 4c (0.058 g, 86% yield) as a white solid mp 216-218 °C [lit. mp. 216-219 °C].$^{14}$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.48 (d, $J$ = 8.4 Hz, 2H), 7.36 (d, $J$ = 8.4 Hz, 2H), 7.02 (s, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 135.7; 131.7; 128.0; 127.8; 121.5.

\textit{(E)-1,2-bis(4-((E)-phenyldiazenyl)phenyl)ethene 4d.} The reaction of (E)-4-(phenyldiazenyl)benzenediazonium tosylate 2h (0.4 mmol, 0.124 g) and potassium vinyltrifluoroborate according to the general procedure during 5 min afforded compound 4d (0.067 g, 86% yield) as an red solid mp = 199-201 °C. $^1$H NMR (400 MHz, DMSO-d$_7$ 70 degrees): $\delta$ 7.94-7.86 (m, 5 H), 7.62-7.56 (m, 4H), 7.52 (s, 1H); HRMS (TOF MS ES+): calcd for C$_{22}$H$_{21}$N$_4$ (M+H$^+$) 389.1766; found 389.1764.

\textit{(E)-2,2'-dinitrostilbene 4e.} According to the general procedure, the reaction of 2-nitrobenzenediazonium tosylate 2j (0.4 mmol, 0.128 g) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) for 13 min afforded compound 4e (0.045 g, 83% yield) as a white solid mp 199-201 °C [lit. 204 °C].$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.05 (d, $J$ = 8.4 Hz, 2H), 7.82 (d, $J$ = 8.0 Hz, 1H), 7.69-7.66 (t, $J$ = 7.6 MHz, 1H), 7.57 (s, 1H), 7.51-7.47 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 133.8; 132.7; 129.2; 129.1; 129.0; 125.0.

\textit{(E)-1,2-di-p-tolylethene 4f.} According to the general procedure, the reaction of 4-methylbenzenediazonium tosylate 2n (0.4 mmol, 0.116 g) with potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) for 1 min afforded compound 4f (0.013 g, 31% yield) as a white solid mp 178-180 °C [lit.177-179 °C].$^{16}$H NMR (300 MHz, CDCl$_3$): $\delta$ 7.40 (d, $J$ = 8.1 Hz, 2H), 7.16 (d, $J$ = 8.1 Hz, 2H), 7.04 (s, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 137.8; 135.3; 129.9; 128.2; 126.9; 21.9.

3. General Procedure for preparation of unsymmetrical stilbenes from vinyl-BF$_3$K and ADT. To a solution of ADT (0.2 mmol) and potassium vinyltrifluoroborate (0.3 mmol, 0.040 g) water/acetonitrile (5 mL, 1/1) was added Pd(OAc)$_2$ (1 mol%). The reaction mixture was stirred until the cessation of the nitrogen evolution, then the second (0.2 mmol) was added to
reaction mixture. The reaction vessel was placed into a microwave reactor (70 °C, 30 bars). After completion, brine was added, the reaction mixture was extracted with CHCl₃ (3×50 mL) and dried over anhydrous MgSO₄. The organic extracts were filtered through short silica pad. The solvent was removed in vacuo to give the corresponding stilbenes without further purification.

(E)-1-methyl-4-(4-nitrostyryl)benzene. 4g. The reaction of 4-nitrobenzenediazonium tosylate 2a (0.2 mmol, 0.064 g), 4-methylbenzenediazonium tosylate 2n (0.2 mmol, 0.058 g) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) afforded compound 4g (0.039 g, 82 % yield) as a white solid mp 148- 150 °C [lit. 150 °C.17]. 1H NMR (400 MHz, DMSO-d₆): δ 8.22 (d, J = 9.2 Hz, 2H), 7.85 (d, J = 8.8 Hz, 2H), 7.57 (d, J = 8.0 Hz, 2H), 7.51 (d, J = 16.4 Hz, 1H), 7.36 (d, J = 16.8 Hz, 1H), 7.23 (d, J = 8.0 Hz, 2H), 2.32 (s, 3H); 13C NMR (100 MHz, DMSO-d₆): δ 146.0; 144.3; 138.4; 133.6; 129.5; 127.2; 127.2; 125.4; 124.1; 21.0.

(E)-4-(4-bromostyryl)-1,1'-biphenyl 4h. The reaction of 4-bromobenzenediazonium tosylate 2d (0.2 mmol, 0.071 g), 4-phenylbenzenediazonium tosylate 2f (0.2 mmol, 0.070 g) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) afforded compound 4h (0.064 g, 96 % yield) as a grey solid mp 232- 234 °C [lit. 229-231 °C.18]. 1H NMR (400 MHz, CDCl₃): δ 7.63-7.57 (m, 7H), 7.50-7.43 (m, 4H), 7.41-7.34 (m, 3H), 7.14 (d, J = 16.4 Hz, 1H), 7.08 (d, J = 16.4 Hz, 1H); 13C NMR (100 MHz, CDCl₃): δ 140.8; 140.7; 136.4; 136.1; 132.0; 129.0; 129.0; 128.1; 127.6; 127.1; 127.1; 126.4; 123.7; 123.1. HRMS (TOF MS ESI+): calcd for C₂₀H₁₅N₃O₂ (M+H⁺) 359.0854; found 359.0852.

(E)-1-(4-((E)-4-nitrostyryl)phenyl)-2-phenyldiazene 4i. The reaction of 4-nitrobenzenediazonium tosylate 2a (0.2 mmol, 0.064 g), (E)-4-(phenyldiazenyl)benzenediazonium tosylate 2h (0.2 mmol, 0.076 g) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) afforded compound 4i (0.057 g, 87 % yield) as a white solid mp 238 °C (decomp.). 1H NMR (400 MHz, CDCl₃): δ 8.25 (d, J = 8.4 Hz, 2H), 7.98-7.93 (m, 4H), 7-72-7.67 (m, 4H), 7.56-7.49 (m, 3H), 7.34 (d, J = 16.4 Hz, 1H), 7.25 (d, J = 16.0 Hz, 1H); 13C NMR (100 MHz, CDCl₃): δ 152.8; 152.6; 147.1; 143.6; 138.9; 132.5; 131.4; 129.3; 127.9; 127.2; 124.4; 123.7; 123.1. HRMS (TOF MS ESI+): calcd for C₂₀H₁₆N₃O₂ (M+H⁺) 330.1243; found 330.1246.

(E)-2-(4-(4-nitrostyryl)phenyl)benzothiazole 4j. The reaction of 4-nitrobenzenediazonium tosylate 2a (0.2 mmol, 0.064 g), 4-(benzo[d]thiazol-2-yl)benzenediazonium tosylate 2g (0.2 mmol, 0.085 g) and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) afforded compound 4j (0.056 g, 78 % yield) as a white solid mp 249 °C (decomp.). 1H NMR (400 MHz, CDCl₃): δ 8.25 (d, J = 8.4 Hz, 2H), 8.14 (d, J = 8.4 Hz, 2H), 8.09 (d, J = 8.0 Hz, 1H), 7.93 (d, J = 8.0 Hz, 1H), 7.68 (d, J = 8.8 Hz, 3H), 7.54-7.50 (t, J = 7.2 Hz, 1H), 7.43-7.40 (t, J = 7.2, 6.8 Hz, 1H), 7.32 (d, J = 16.0 Hz, 1H), 7.26 (d, J = 16.4 Hz, 1H); 13C NMR (100 MHz, CDCl₃): δ 143.5; 138.9; 132.3; 128.2; 128.0; 127.7; 127.3; 126.7; 125.6; 124.4; 123.4; 121.8. HRMS (TOF MS ESI+): calcd for C₂₁H₁₄N₂O₂S (M+H⁺) 359.0854; found 359.0852.

(E)-1-(4-methylstyryl)-2-nitrobenzene 4k. The reaction of 2-nitrobenzenediazonium tosylate 2j (0.2 mmol, 0.064 g), 4-methylbenzenediazonium tosylate 2n (0.2 mmol, 0.058 g), and potassium vinyltrifluoroborate (0.2 mmol, 0.027 g) afforded compound 4k (0.023 g, 48 % yield) as an orange oil.19 1H NMR (400 MHz, CDCl₃): δ 7.95 (d, J = 8.4 Hz, 1H), 7.76 (d, J = 8.0 Hz, 1H), 7.61-7.57 (m, 1H), 7.53 (s, 1H), 7.44 (d, J = 7.6 Hz, 2H), 7.40-7.37 (m, 1H), 7.20 (d, J = 7.6 Hz, 1H), 7.12-7.05 (m, 2H), 2.38 (s, 3H); 13C NMR (100 MHz, CDCl₃): δ 138.7; 133.8; 133.7; 133.5; 133.0; 129.5; 128.0; 127.7; 127.0; 124.8; 122.3; 120.0; 21.3.
4. Spectra of products

NMR $^1$H spectrum of 1-nitro-4-vinylbenzene (3a)
NMR $^{13}$C spectrum of 1-nitro-4-vinylbenzene (3a)
NMR $^1$H spectrum of 4-vinylbenzonitrile (3b).
NMR $^{13}$C spectrum of 4-vinylbenzonitrile (3b).
NMR $^1$H spectrum of 4-vinylbenzoic acid (3c).
NMR $^{13}$C spectrum of 4-vinylbenzoic acid (3c).
NMR $^1$H spectrum of 1-bromo-4-vinylbenzene (3d).
NMR $^{13}$C spectrum of 1-bromo-4-vinylbenzene (3d).
NMR $^1$H spectrum of 4-vinylaniline (3e).
NMR $^{13}$C spectrum of 4-vinylaniline (3e).
NMR $^1$H spectrum of 4-vinyl-1,1'-biphenyl (3f)
NMR $^{13}$C spectrum of 4-vinyl-1,1'-biphenyl (3f)
NMR $^1$H spectrum of 2-(4-vinylphenyl)benzo[d]thiazole (3g).
NMR $^{13}$C spectrum of 2-(4-vinylphenyl)benzo[d]thiazole (3g).
NMR $^1$H spectrum of (E)-1-phenyl-2-(4-vinylphenyl)diazene (3h).
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NMR $^1$H spectrum of 5-vinyluracil (3i)
NMR $^{13}$C spectrum of 5-vinyluracil (3i)
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NMR $^{13}$C spectrum of (E)-4,4'-dicyanostilbene (4b).
NMR $^1$H spectrum of (E)-4,4'$\text{-dibromostilbene}$ (4c).
NMR $^{13}$C spectrum of (E)-$4,4'$-dibromostilbene (4c).
NMR $^1$H spectrum of (E)-1,2-bis(4-((E)-phenyldiazenyl)phenyl)ethane (4d).
NMR $^1$H spectrum of (E)-2,2'-dinitrostilbene (4e).
NMR $^{13}$C spectrum of (E)-2,2'-dinitrostilbene (4e).
NMR \(^1\)H spectrum of (E)-1,2-di-p-tolylethene (4f)
NMR $^{13}$C spectrum of (E)-1,2-di-p-tolylethene (4f)
NMR $^1$H spectrum of (E)-1-methyl-4-(4-nitrostyryl)benzene (4g).
NMR $^{13}$C spectrum of (E)-1-methyl-4-(4-nitrostyryl)benzene (4g).
NMR $^1$H spectrum of (E)-4-(4-bromostyryl)-1,1'-biphenyl (4h).
NMR $^{13}$C spectrum of (E)-4-(4-bromostyryl)-1,1'-biphenyl (4h).
NMR $^1$H spectrum of (E)-1-(4-((E)-4-nitrostyryl)phenyl)-2-phenyldiazene (4i)
NMR $^{13}$C spectrum of (E)-1-(4-((E)-4-nitrostyryl)phenyl)-2-phenyldiazene (4i)
NMR $^1$H spectrum of (E)-2-(4-(4-nitrostyryl)phenyl)benzothiazole (4j).
NMR $^{13}$C spectrum of (E)-2-(4-(4-nitrostyryl)phenyl)benzothiazole (4j).
NMR $^1$H spectrum of (E)-1-(4-methylstyryl)-2-nitrobenzene (4k)
NMR $^{13}$C spectrum of (E)-1-(4-methylstyryl)-2-nitrobenzene (4k)
References

1. S.E. Estrada, C. Ochoa-Puentes, C.A. Sierra. *Journal of Molecular Structure*, 2017, **1133**, 448;