

Supplementary Information

**A new dual functional and reusable bimetallic Y_2ZnO_4
nanocatalyst for organic transformation under Microwave/Green
approach**

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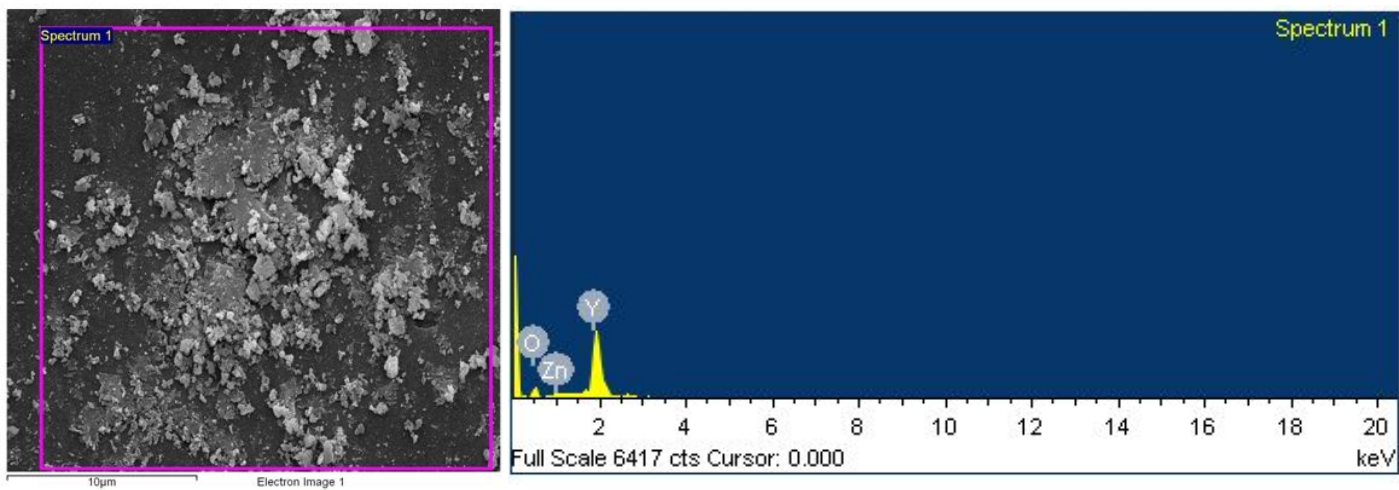


Figure S1. Energy dispersive X-ray (EDX) spectrum of Y_2ZnO_4

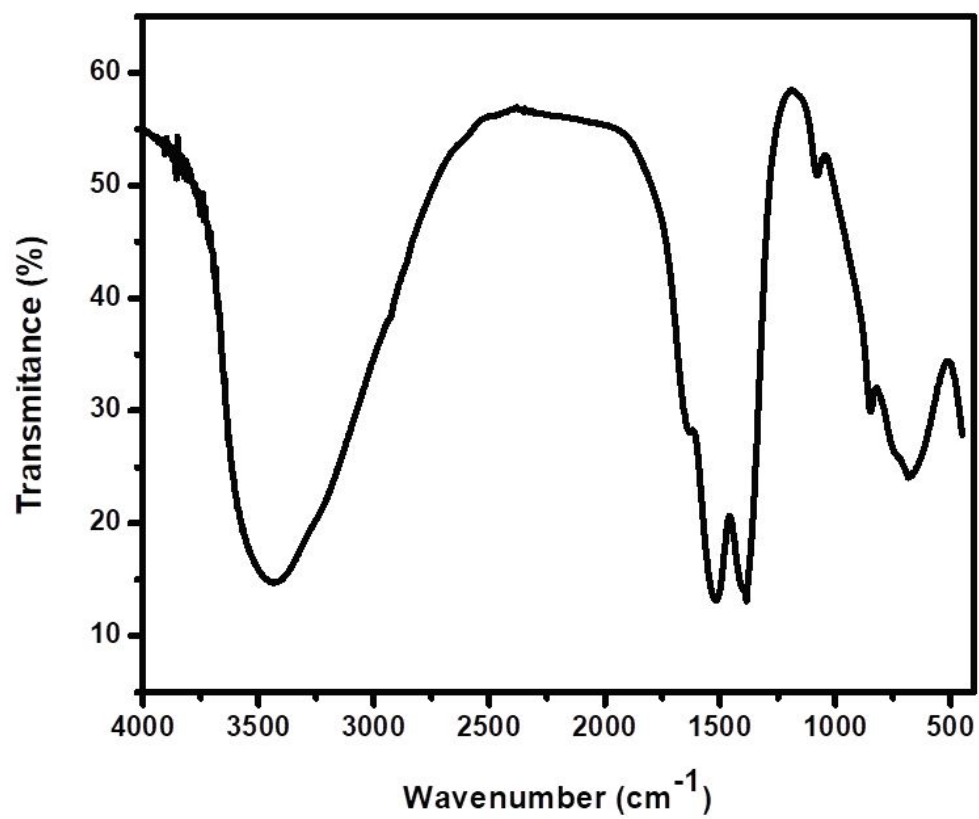


Figure S2. FT-IR spectra for Y_2ZnO_4

General information

All chemicals used in the experiments were obtained from commercial resource and used without further purification. The ^1H NMR spectrum was recorded in 400 MHz FT NMR instrument using CDCl_3 as Solvent. The yield of the products was calculated from ^1H NMR of the crude reaction mixture using phenanthrene as a standard. All ^1H NMR spectra shown below (S 3-11) were recorded in the presence of phenanthrene as a standard. ^1H NMR peak of the products was assigned and confirmed by the comparison with literature data.¹⁻⁵

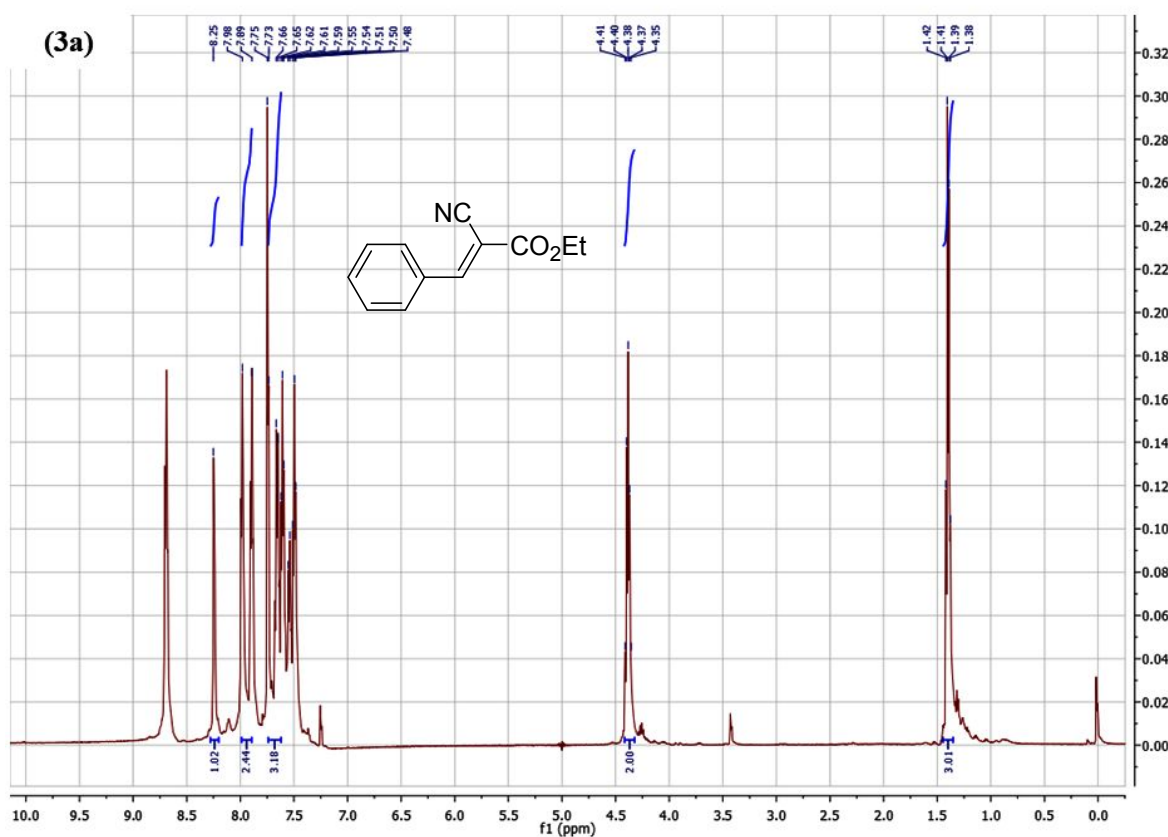


Figure S3: ^1H NMR spectrum of 2-Cyano-3-phenyl-acrylic acid ethyl ester (3a) with standard phenanthrene

[2-Cyano-3-phenyl-acrylic acid ethyl ester (3a).^{1 40} ^1H NMR (400 MHz, CDCl_3) δ : 8.2 (s, 1H), 7.94 (d, $J = 7.2$ Hz, 2H), 7.75-7.50 (m, 3H), 4.40 (q, $J = 7.2$ Hz, 2H), 1.41 (t, $J = 7.1$ Hz, 3H). Yield 92% (The yield was calculated from ^1H NMR using phenanthrene as a standard)]

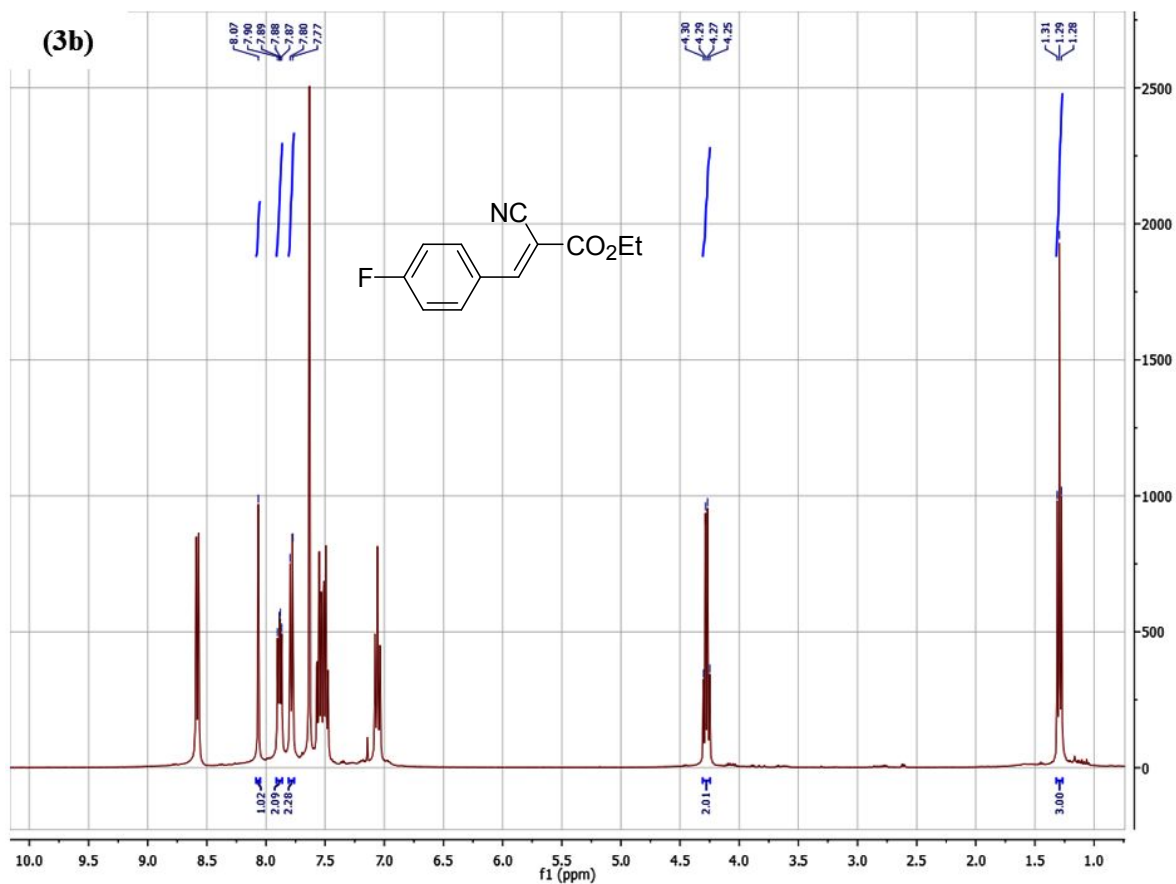


Figure S4: ¹H NMR spectrum of 2-Cyano-3-(4-fluoro-phenyl)-acrylic acid ethyl ester (3b) with standard phenanthrene

[2- Cyano-3-(4-fluoro-phenyl)-acrylic acid ethyl ester (3b).² ¹H NMR (400 MHz, CDCl₃)
 δ: 8.07 (s, 1H), 7.87 (d, *J* = 7.8 Hz, 2H), 7.78 (d, *J* = 7.8 Hz, 2H), 4.27 (q, *J* = 7.1 Hz, 2H),
 1.29 (t, *J* = 7.1 Hz, 3H). Yield 81% (The yield was calculated from ¹H NMR using
 phenanthrene as a standard)]

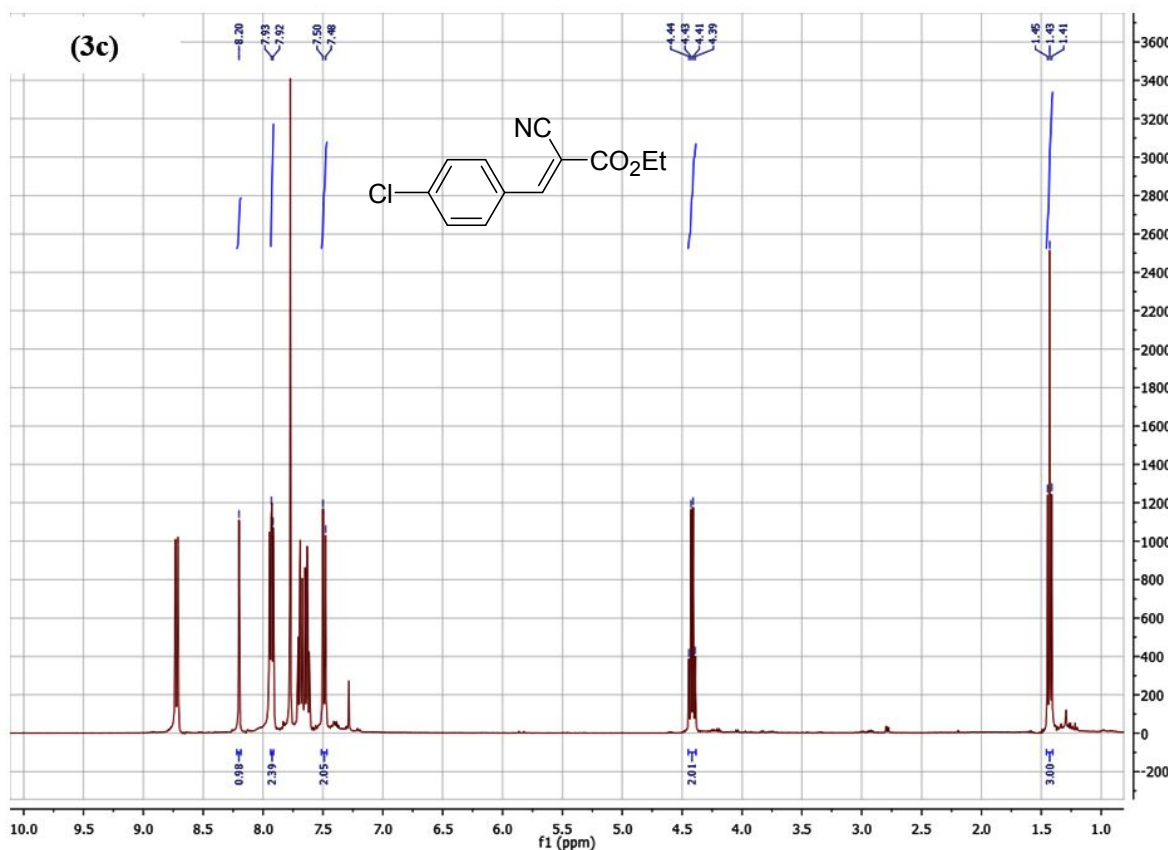


Figure S5: ¹H NMR spectrum of 2-Cyano-3-(4-chloro-phenyl)-acrylic acid ethyl ester (3c) with standard phenanthrene

[2- Cyano-3-(4-chloro-phenyl)-acrylic acid ethyl ester (3c).¹H NMR (400 MHz, CDCl₃)
 δ : 8.20 (s, 1H), 7.93 (d, J = 8.0 Hz, 2H), 7.49 (d, J = 8.0 Hz, 2H), 4.42 (q, J = 7.1 Hz, 2H),
 1.43 (t, J = 7.1 Hz, 3H). Yield 79% (The yield was calculated from ¹H NMR using
 phenanthrene as a standard)]

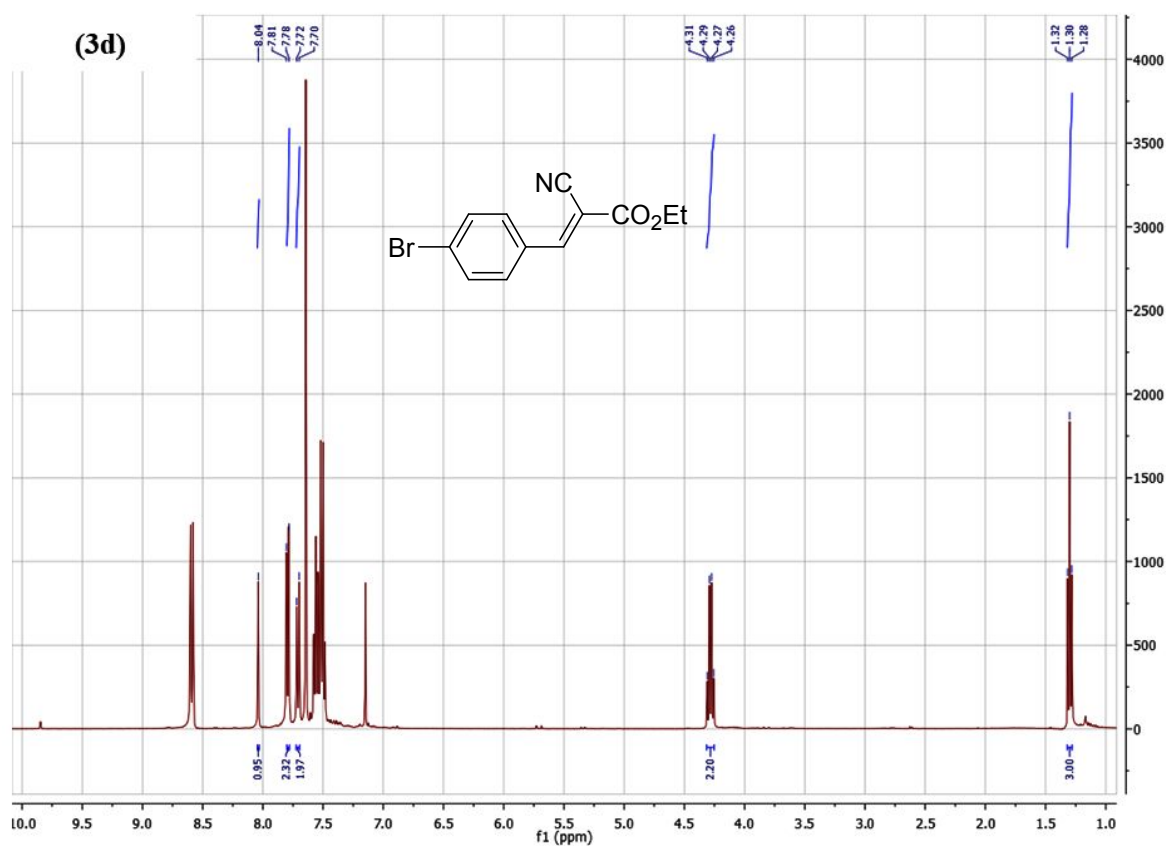


Figure S6: ¹H NMR spectrum of 2-Cyano-3-(4-bromo-phenyl)-acrylic acid ethyl ester (3d) with standard phenanthrene

[2-Cyano-3-(4-bromo-phenyl)-acrylic acid ethyl ester (3d). ¹H NMR (400 MHz, CDCl₃)
 δ : 8.04 (s, 1H), 7.79 (d, $J = 8.0$ Hz, 2H), 7.71 (d, $J = 8.0$ Hz, 2H), 4.28 (q, $J = 7.1$ Hz, 2H),
 1.30 (t, $J = 7.1$ Hz, 3H). Yield 83% (The yield was calculated from ¹H NMR using
 phenanthrene as a standard)]

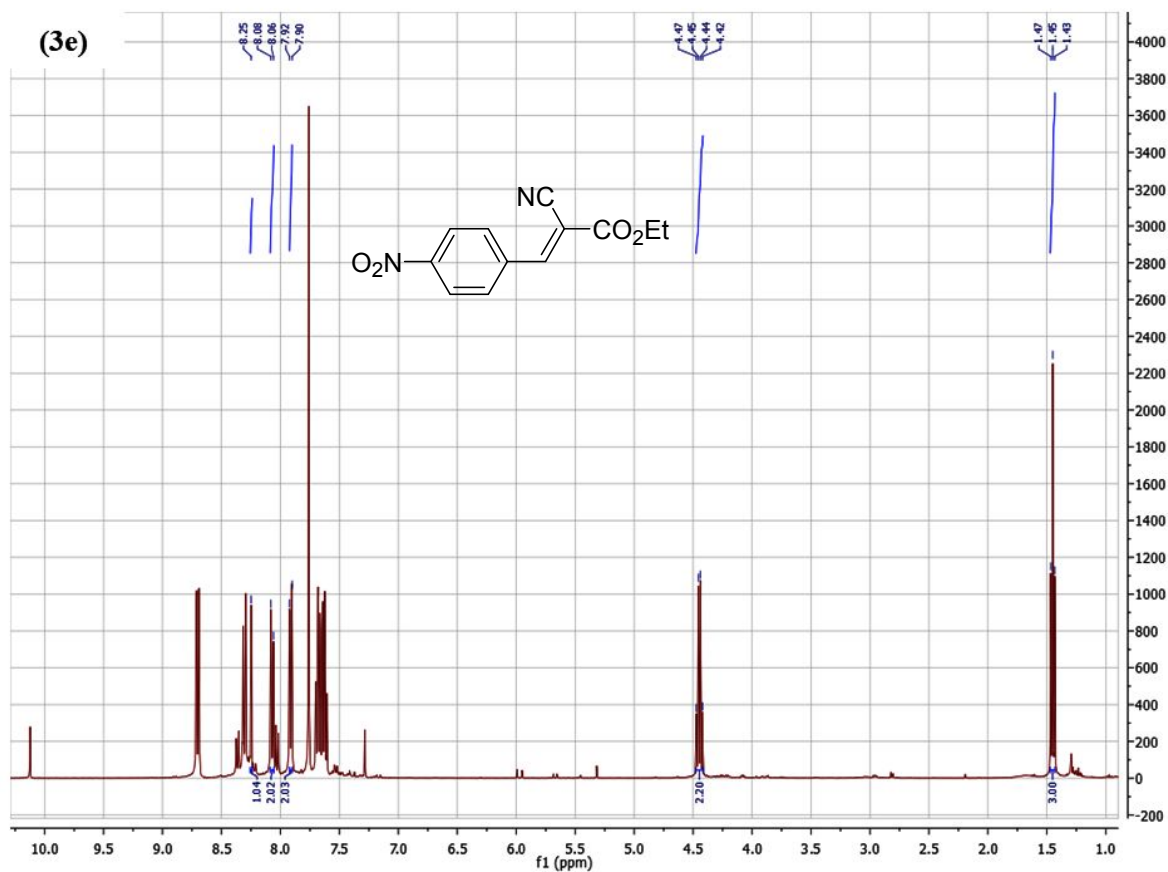


Figure S7: ¹H NMR spectrum of 2-Cyano-3-(4-nitro-phenyl)-acrylic acid ethyl ester (3e) with standard phenanthrene

[2-Cyano-3-(4-nitro-phenyl)-acrylic acid ethyl ester (3e).³ ¹H NMR (400 MHz, CDCl₃) δ: 8.25 (s, 1H), 8.07 (d, *J* = 8.0 Hz, 2H), 7.91 (d, *J* = 7.6 Hz, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 1.45 (t, *J* = 7.1 Hz, 3H). Yield 88% (The yield was calculated from ¹H NMR using phenanthrene as a standard)]

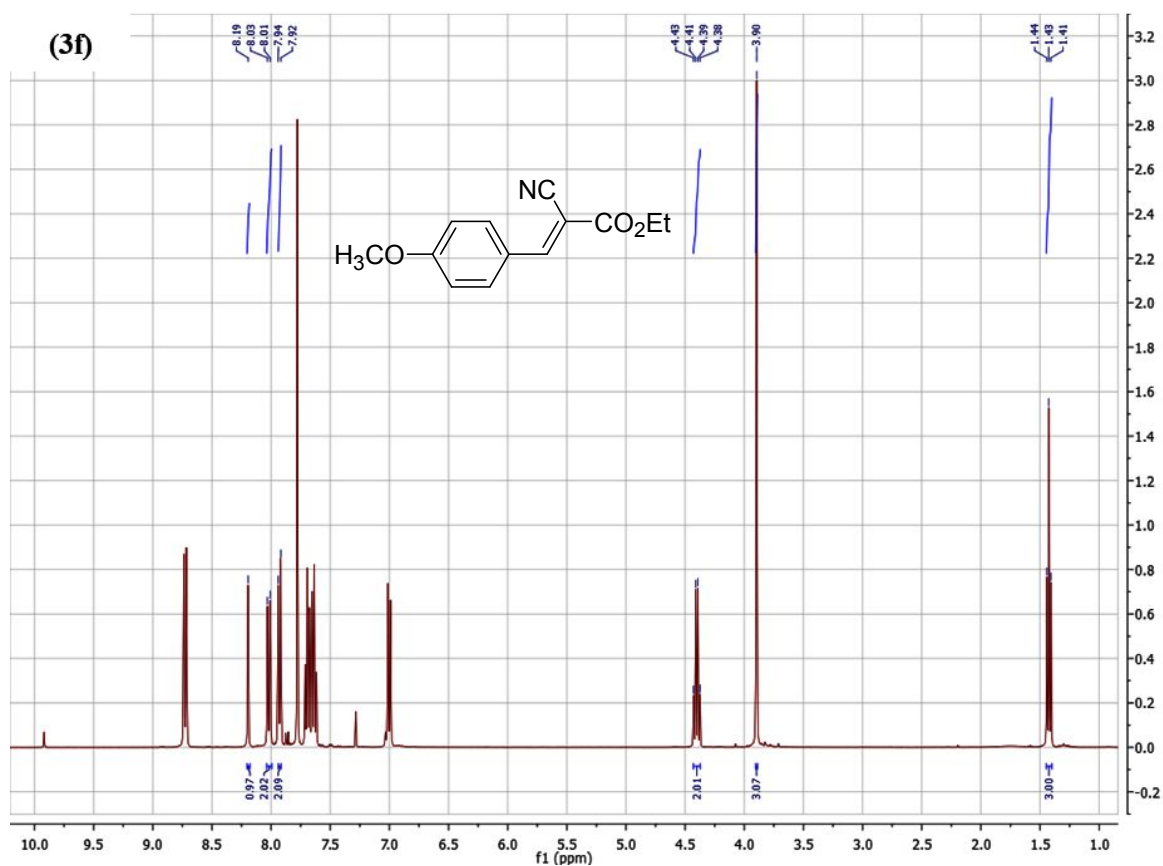


Figure S8: ¹H NMR spectrum of 2-Cyano-3-(4-methoxy-phenyl)-acrylic acid ethyl ester (3f) with standard phenanthrene

[2-Cyano-3-(4-methoxy-phenyl)-acrylic acid ethyl ester (3f).¹ ¹H NMR (400 MHz, CDCl₃) δ: 8.19 (s, 1H), 8.02 (d, *J* = 8.0 Hz, 2H), 7.93 (d, *J* = 8 Hz, 2H), 4.40 (q, *J* = 7.1 Hz, 2H), 3.90 (s, 3H), 1.43 (t, *J* = 7.1 Hz, 3H). Yield 90% (The yield was calculated from ¹H NMR using phenanthrene as a standard)]

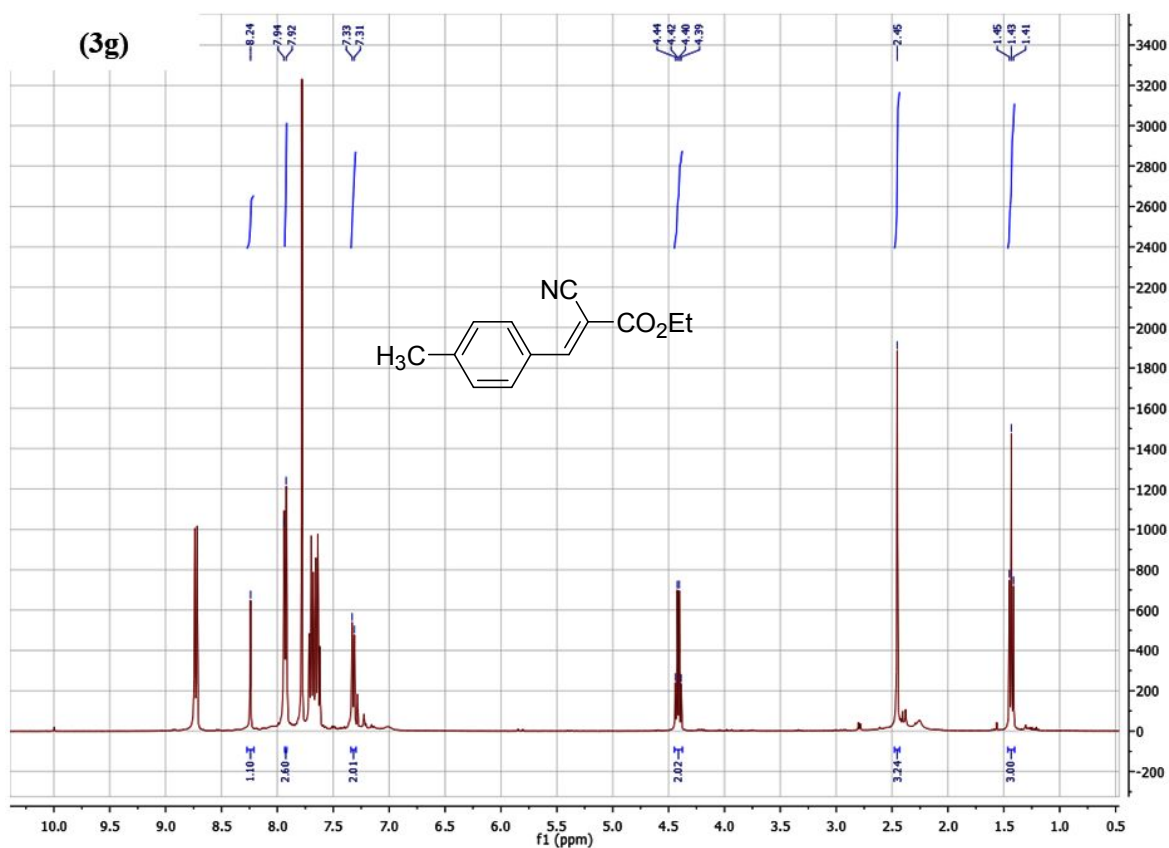


Figure S9: ^1H NMR spectrum of 2-Cyano-3-p-tolyl-acrylic acid ethyl ester (3g) with standard phenanthrene

[2-Cyano-3-p-tolyl-acrylic acid ethyl ester (3g).¹ ^1H NMR (400 MHz, CDCl_3) δ : 8.24 (s, 1H), 7.93 (d, $J = 8.0$ Hz, 2H), 7.32 (d, $J = 8$ Hz, 2H), 4.41 (q, $J = 8.0$ Hz, 2H), 2.45 (s, 3H), 1.43 (t, $J = 8.0$ Hz, 3H). Yield 86% (The yield was calculated from ^1H NMR using phenanthrene as a standard)]

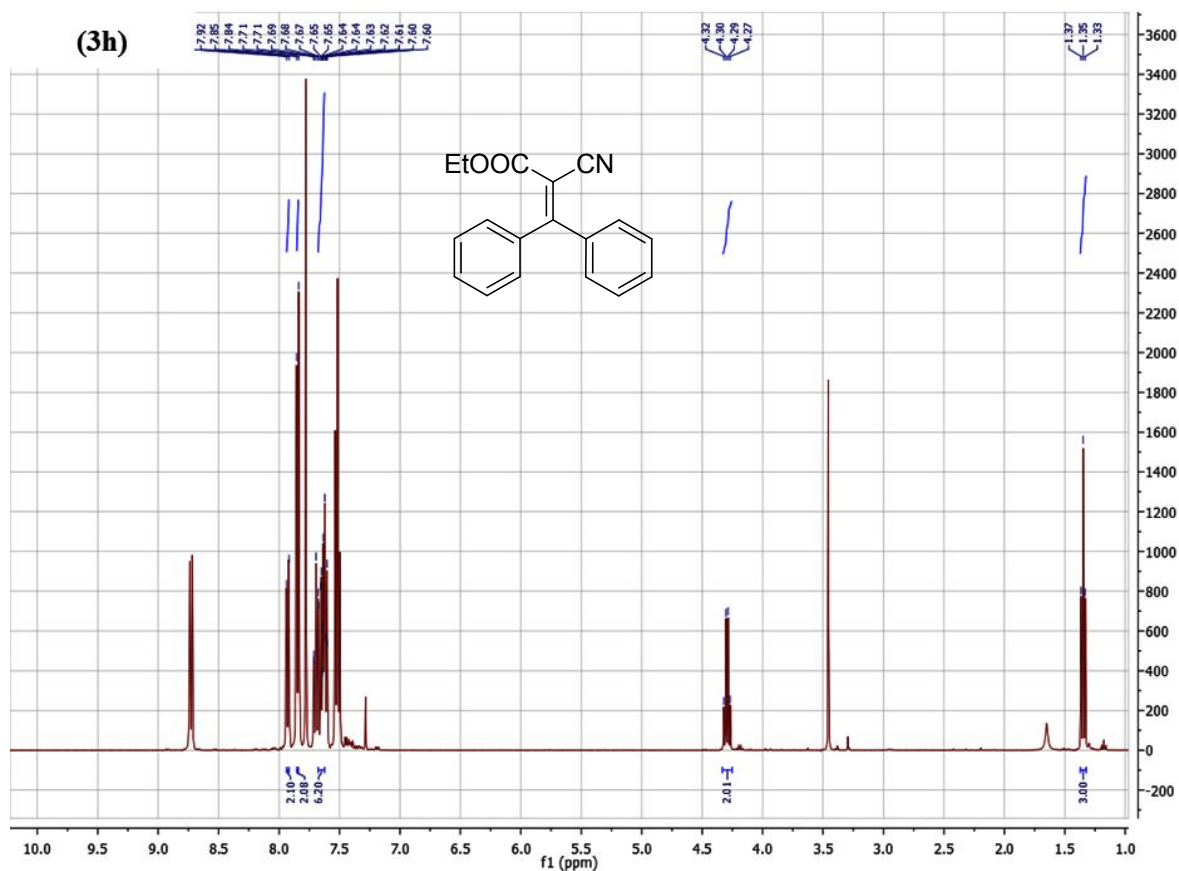


Figure S10: ^1H NMR spectrum of 2-Cyano-3,3-diphenyl -acrylic acid ethyl ester (3h) with standard phenanthrene

[2-Cyano-3,3-diphenyl -acrylic acid ethyl ester (3h).⁴ ^1H NMR (400 MHz, CDCl_3) δ : 7.93 (d, $J = 8.0$ Hz, 2H), 7.84 (d, $J = 8.0$, 2H), 7.60-7.71 (m, 6H), 4.29 (q, $J = 8.0$ Hz, 2H) and 1.35 (t, $J = 8.0$ Hz, 3H). Yield 85% (The yield was calculated from ^1H NMR using phenanthrene as a standard)]

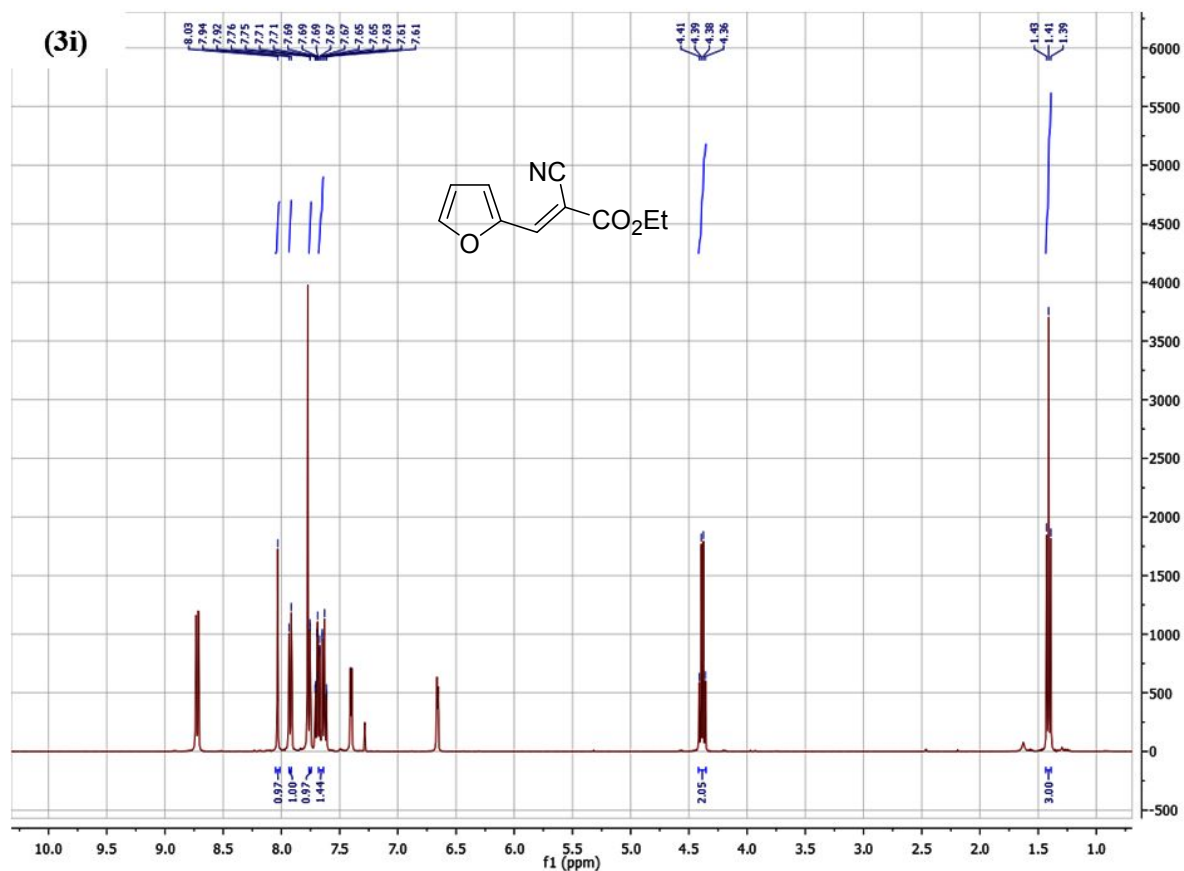


Figure S11: ^1H NMR spectrum of 2-Cyano-3 furan-2-yl-acrylic acid ethyl ester (3i) with standard phenanthrene

[2-Cyano-3 furan-2-yl-acrylic acid ethyl ester (3i).⁵ ^1H NMR (400 MHz, CDCl_3) δ : 8.03 (s, 1H), 7.92 (d, $J = 8.0$ Hz, 1H), 7.76 (d, $J = 8.0$ Hz, 1H), 7.66 (m, 1H), 4.39 (q, $J = 8.0$ Hz, 2H) and 1.41 (t, $J = 8.0$ Hz, 3H). Yield 84% (The yield was calculated from ^1H NMR using phenanthrene as a standard)]

Table S1. Element analysis and determination of Weight% and Atomic% of Y₂ZnO₄

Element	Weight %	Atomic %
Yttrium	25.12	28.52
Zinc	16.6	14.28
Oxygen	58.28	57.20
Total	100	100

Reference

1. Wan, J. P.; Jing, Y.; Liu, Y.; Sheng, S. Metal-free synthesis of cyano acrylates via cyanuric chloride-mediated three-component reactions involving a cascade consists of Knoevenagel condensation/cyano hydration/esterification. *RSC Adv.* **2014**, *4*, 63997-64000.
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