

Electronic Supplementary Information

Microwave-Assisted Biodiesel Production Using UiO-66 MOF Derived Nanocatalyst: Process Optimization Using Response Surface Methodology

Shiva Prasad Gouda ¹, Jasha Momo H. Anal ^{2,3}, Puneet Kumar ^{2,3}, Amarajothi Dhakshinamoorthy ⁴, Umer Rashid ⁵ and Samuel Lalthazuala Rokhum ^{1,*}

¹ Department of Chemistry, National Institute of Technology Silchar, Silchar 788010, India

² Natural Products and Medicinal Chemistry Division, CSIR—Indian Institute of Integrative Medicine, Jammu 180001, India

³ Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India

⁴ School of Chemistry, Madurai Kamaraj University, Madurai 625021, India

⁵ Institute of Nanoscience and Nanotechnology, Universiti Putra Malaysia, Serdang 43400, Malaysia

* Correspondence: rokhum@che.nits.ac.in

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1.	XPS survey spectrum of CaO-ZrO ₂	Figure S1
2.	XRD of (a) pure CaO and snail-shell-derived-CaO, (b) m-ZrO ₂ , t-ZrO ₂ , UiO-66 derived ZrO ₂ , and CaO-ZrO ₂ catalyst.	Figure S2
3.	¹ H and ¹³ C NMR spectra of the synthesized biodiesel.	Figure S3
4.	FT-IR spectrum of synthesized biodiesel	Figure S4
5.	EDS spectrum of the recovered catalyst after 5 transesterification cycles.	Figure S5
6.	TOF calculation.	

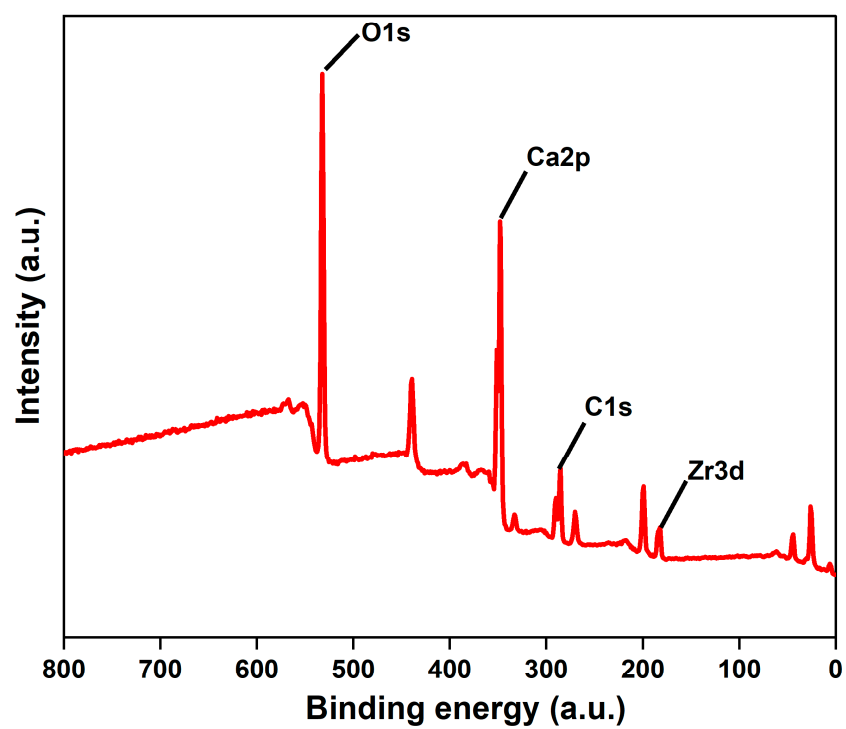


Figure S1. XPS survey spectrum of CaO-ZrO₂

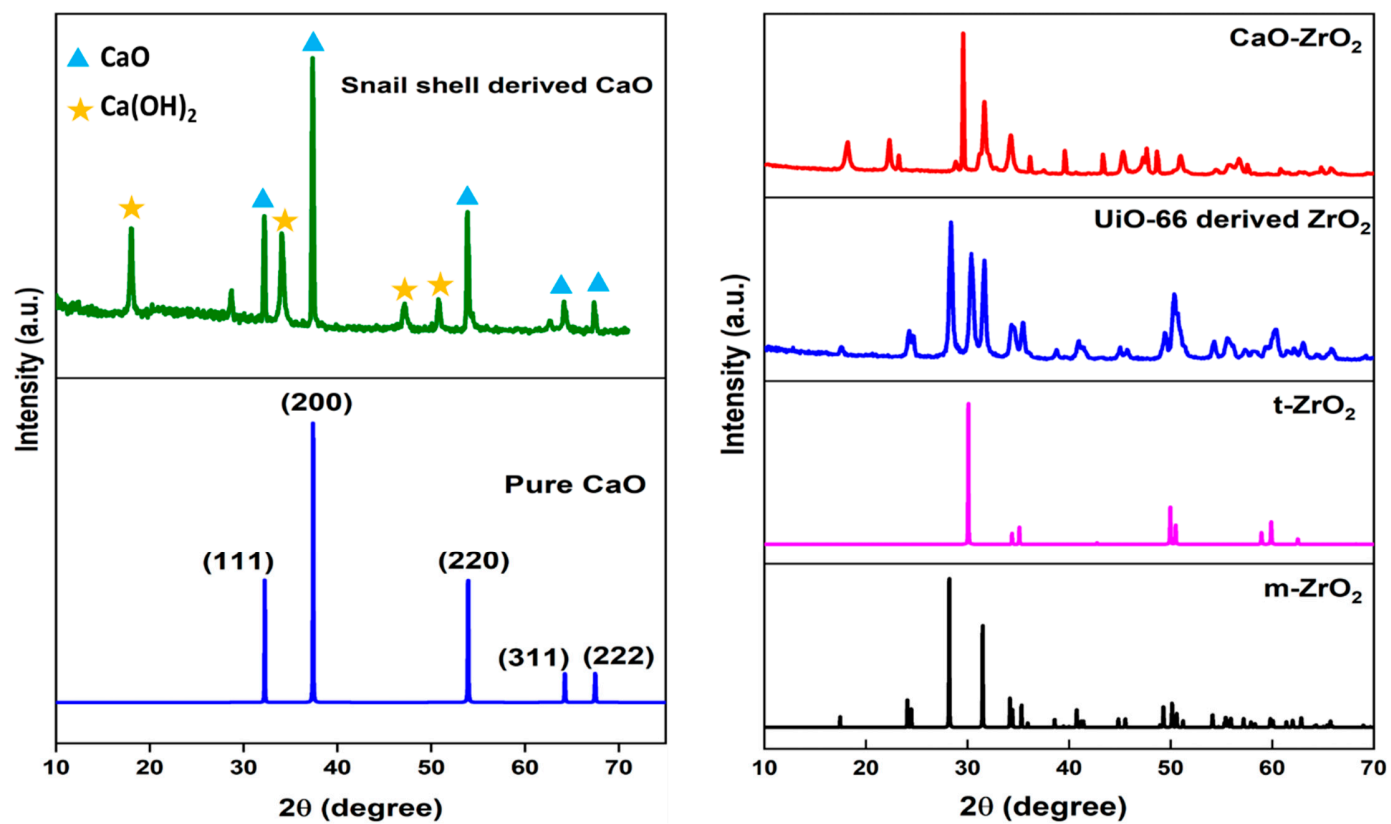


Figure S2. XRD of (a) pure CaO and snail-shell-derived-CaO, (b) m-ZrO₂, t-ZrO₂, UiO-66 derived ZrO₂ and CaO-ZrO₂ catalyst.

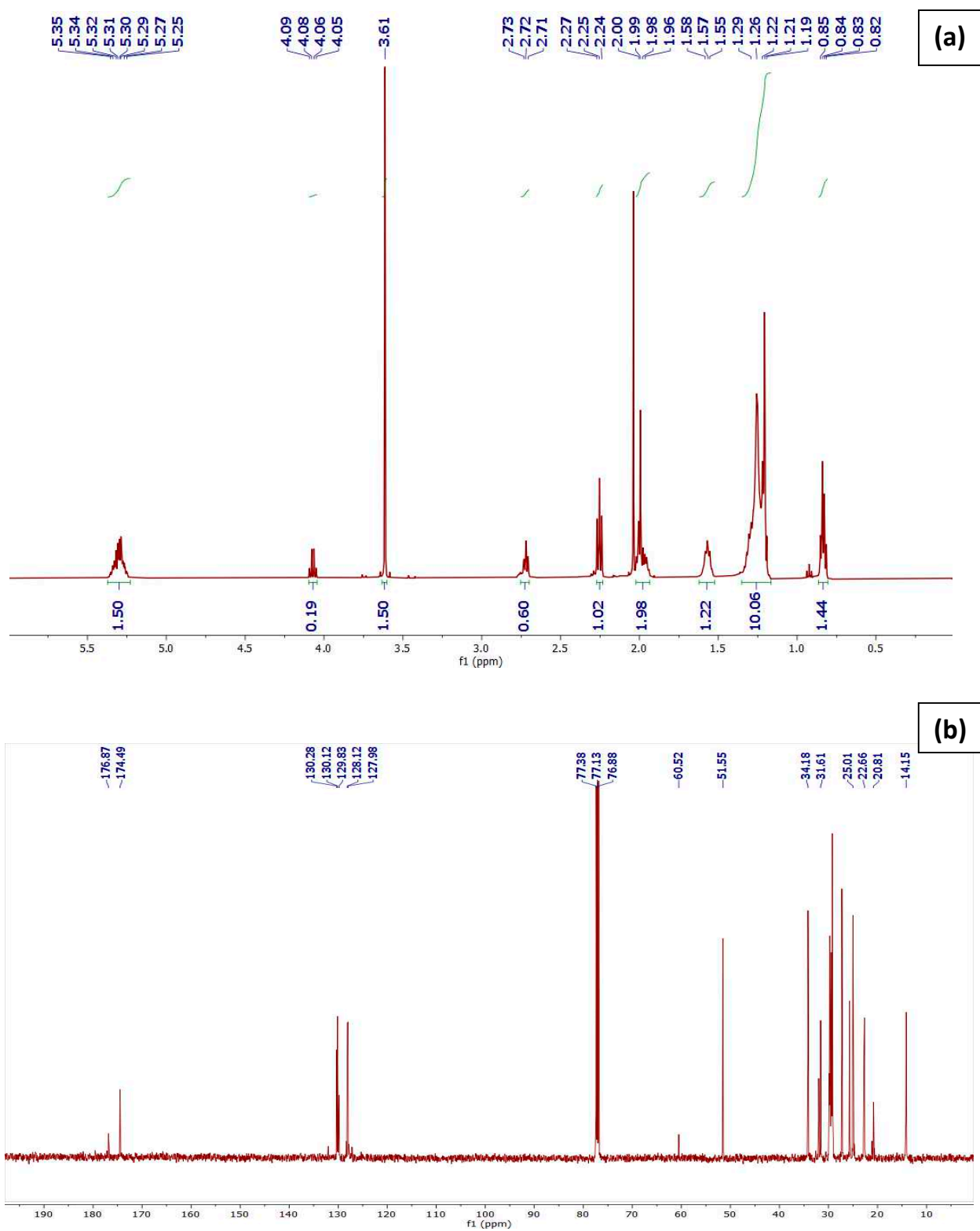


Figure S3. ^1H (a) and ^{13}C NMR (b) spectra of synthesized biodiesel.

Representative ^1H NMR spectra (500 MHz, CDCl_3 , 27 $^\circ\text{C}$) (a) Biodiesel produced using CaO-ZrO_2 catalyst (conditions: 10:1 MTOR molar, 6 wt. % catalyst loading, 1 h reaction time and 70 $^\circ\text{C}$ reaction temperature). (b) Corresponding representative ^{13}C NMR spectrum (126 MHz, CDCl_3 , 27 $^\circ\text{C}$) for biodiesel produced using CaO-ZrO_2 nanocatalyst. The corresponding numerical spectroscopic data for synthesized biodiesel are: **^1H NMR** (500 MHz, CDCl_3 , 27 $^\circ\text{C}$): δ 5.3 (m, 2H), 4.06 (q, 2H), 3.61 (s, 3H), 2.72 (m, 2H), 2.25 (t, 4H), 2 (m, 2H), 1.57 (m, 2H), 1.23 (m, 20H), 0.84 (m, 2H). **^{13}C NMR** (126 MHz, CDCl_3 , 27 $^\circ\text{C}$): δ 176.87, 129.83, 128.12, 60.52, 51.55, 34.18, 25.01, 22.66, 20.81, 14.15

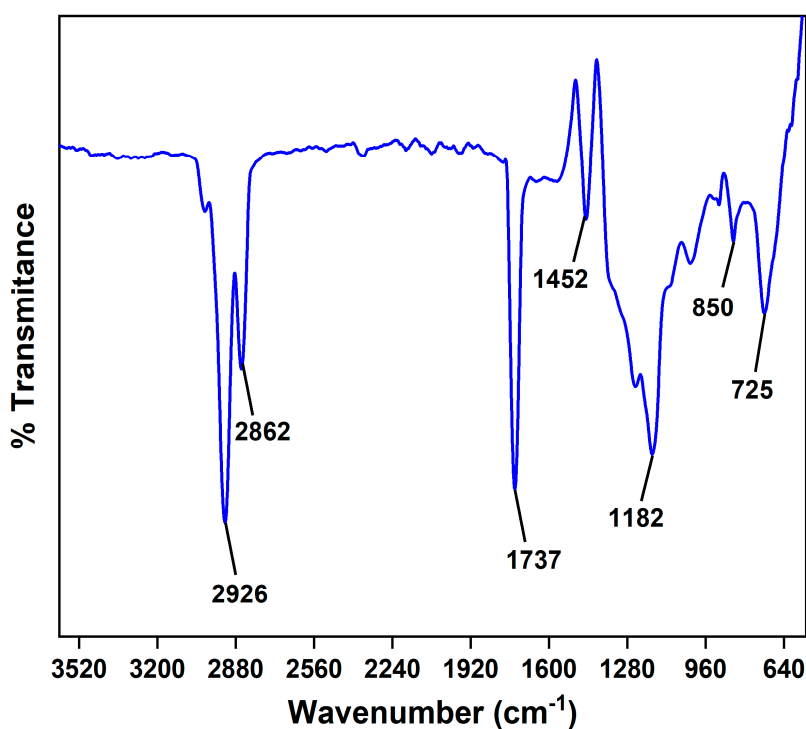


Figure S4. FT-IR spectrum of synthesized biodiesel.

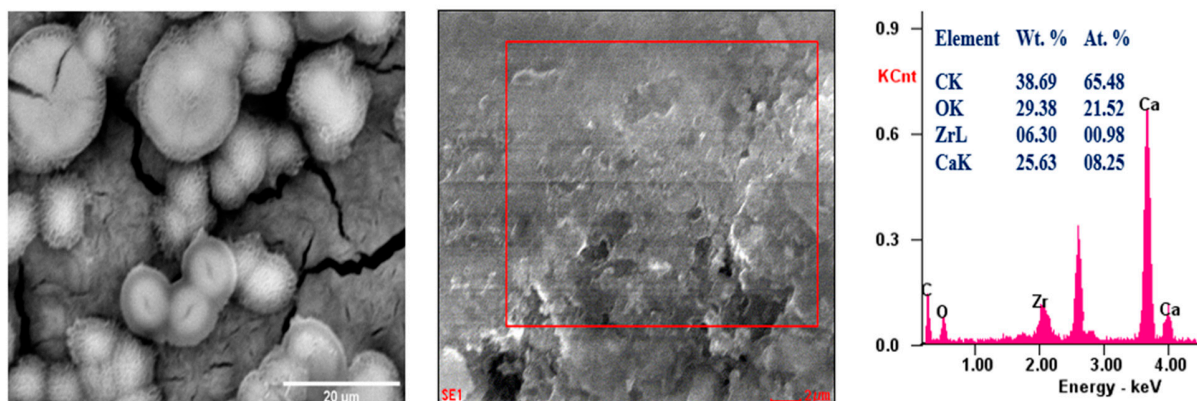


Figure S5. EDS spectrum of the recovered catalyst after 5 transesterification cycles.

Turnover frequency (TOF) calculation

$$\text{TOF} = \frac{\% \text{ Conversion of soybean oil}}{(\text{Time})(\text{Catalyst wt.})(\text{Molar mass of soybean oil})} \quad (\text{Eq. S1})$$