Eco-friendly Mechanochemical Preparation of Ag_2O–MnO_2/graphene oxide Nanocomposite: An efficient and reusable catalyst for the base-free, aerial oxidation of alcohols

Syed Farooq Adil[1,*], Mohamed E. Assal[1], Mujeeb Khan[1], Mohammed Rafi Shaik[1], Mufsir Kuniyil[1], Doumbia Sekou[1], Ahmed Z. Dewidar[2], Abdulrahman Al-Warthan[1], and Mohammed Rafiq H Siddiqui[1,*]

[1] Chemistry Department, College of Science, King Saud University, P.O. 2455, Riyadh 11451, Kingdom of Saudi Arabia.

[2] Agricultural Engineering Department, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

* Correspondence email: rafiqs@ksu.edu.sa, sfadil@ksu.edu.sa

The FTIR spectra of GRO and (1%)Ag_2O–MnO_2/(5 wt.%)GRO are presented in Figure S1. In the spectrum of pristine GRO, the characteristic broad band is located at 3450 cm^{-1}, due to O–H stretching vibration of adsorbed H_2O and −COOH groups. The intense peak at 1737 cm^{-1} was indexed as the C=O stretching vibrations of −COOH groups, and the peak situated at approximately 1630 cm^{-1} belonged to the stretching vibrations of C−C/C=C carbon backbone in the un-oxidized graphitic domains. Besides, the three peaks appeared at 1060 , 1228 and 1397 cm^{-1} were appeared due to the stretching vibrations of C–O (alkoxy), C–O–C (epoxy) and C–OH groups, correspondingly. As expected, the spectra of (1%)Ag_2O–MnO_2/(5 wt.%)GRO nanocomposite displayed all the characteristic peaks of GRO due to the presence of oxygen containing functional groups at 1060 cm^{-1} (C–O), 1397 cm^{-1} (C–OH) and 1737 cm^{-1} (C=O). In addition the appearance of intense sharp peak at ~584 cm^{-1} is attributed to stretching vibrations of various Mn–O bonds, which confirms the formation of composite.

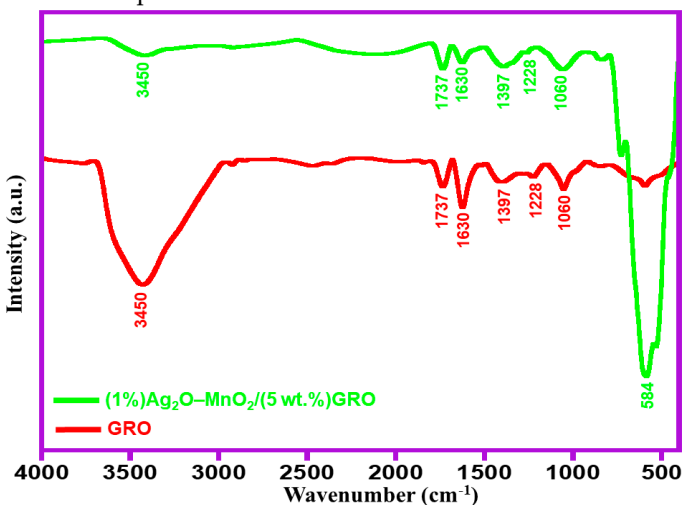
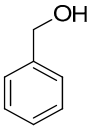
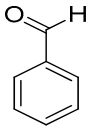
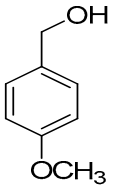
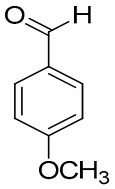
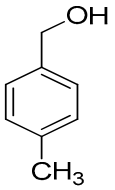
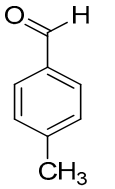
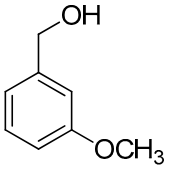
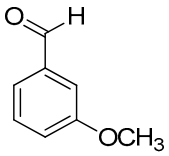
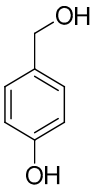
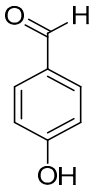
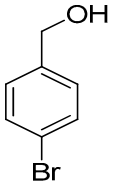
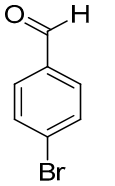
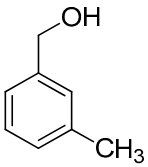
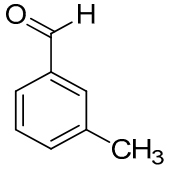
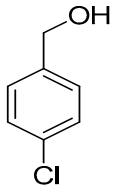
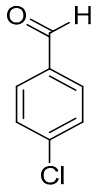
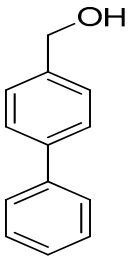
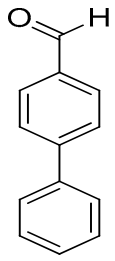
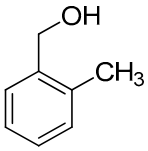
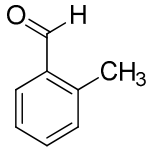
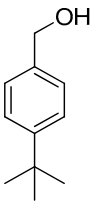
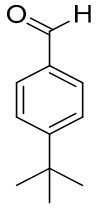
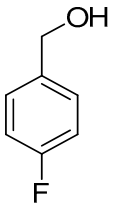
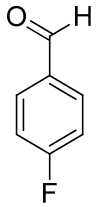
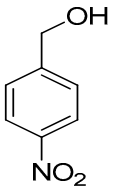
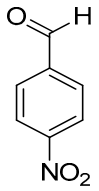
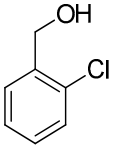
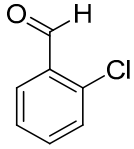
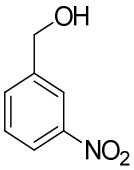
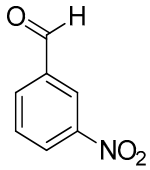
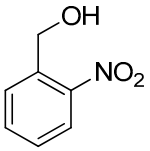
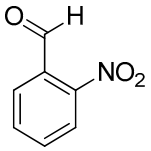
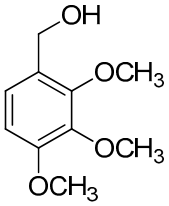
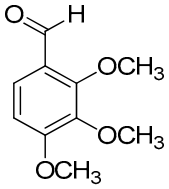
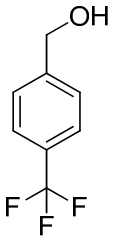
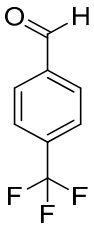
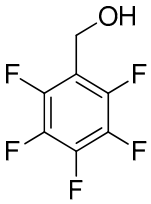
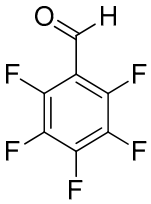
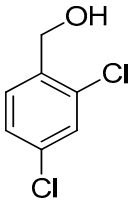
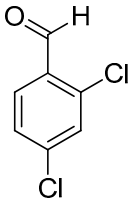
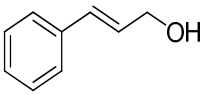
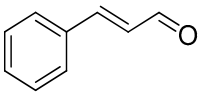
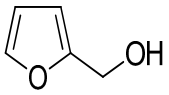
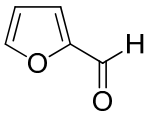
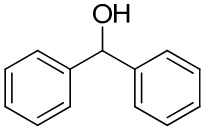
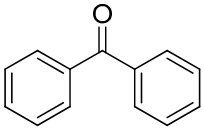
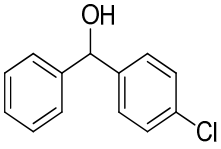
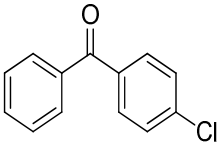


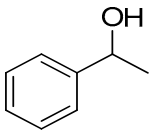
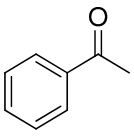
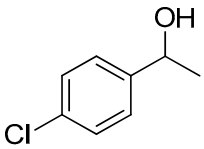
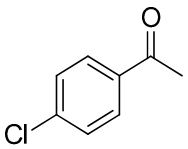
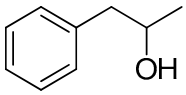
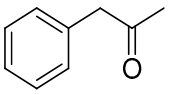
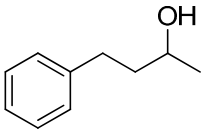
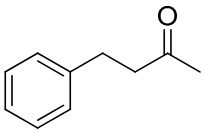
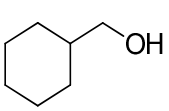
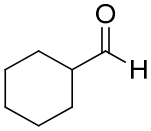
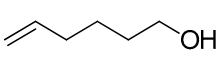
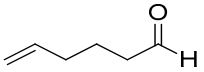
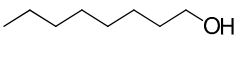
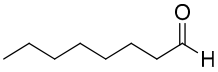
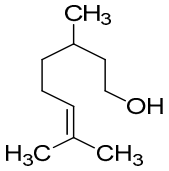
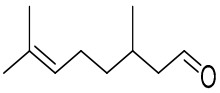
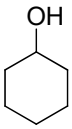
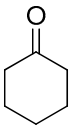
Figure S1. FTIR spectrum of GRO and (1%)Ag_2O–MnO_2/(5 wt.%)GRO nanocomposite.

Table S1. Aerial oxidation of several kinds of alcohols using Ag_2O–MnO_2/(5 wt.%)GRO with O_2 under alkali free conditions.

Entry	Substrate	Product	t. (min)	Conv. (%)/ Sel. (%)
1			30	100/ >99
2			30	100/ >99
3			35	100/ >99
4			40	100/ >99
5			35	100/ >99
6			45	100/ >99
7			45	100/ >99

8			50	100/ >99
9			45	100/ >99
10			50	100/ >99
11			45	100/ >99
12			55	100/ >99
13			55	100/ >99
14			65	100/ >99
15			60	100/ >99

16			70	100/ >99
17			60	100/ >99
18			60	100/ >99
19			75	100/ >99
20			80	100/ >99
21			50	100/ >99
22			110	100/ >99
23			25	100/ >99
24			30	100/ >99

25			25	100/ >99
26			35	100/ >99
27			45	100/ >99
28			55	100/ >99
29			80	100/ >99
30			180	100/ >99
31			220	100/ >99
32			120	100/ >99
33			85	100/ >99
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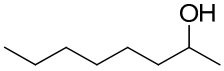
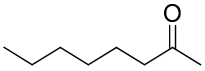
35			240	100/ >99

Conditions: 2 mmol alcohol, 15 mL toluene, 300 mg Ag_2O–MnO_2/(5 wt.%)GRO catalyst, 20 $mL.min^{-1}$ O_2 rate and 100 °C.

3.4. Catalyst Characterization

Scanning electron microscopy (SEM) and elemental analysis (Energy Dispersive X–Ray Analysis: EDX) were carried out using Jeol SEM model JSM 6360A (Japan). This was used to determine the morphology of nanoparticles and its elemental composition. Powder X–ray diffraction studies were carried out using Altima IV [Make: Regaku] X–ray diffractometer. Fourier Transform Infrared Spectroscopy (FTIR) spectra were recorded as KBr pellets using a Perkin- Elmer 1000 FTIR spectrophotometer. BET surface area was measured on a NOVA 4200e surface area & pore size analyzer. Thermogravimetric Analysis was carried out using Perkin-Elmer Thermogravimetric Analyzer 7.