

Supplementary Information for

Synergizing graphene oxide with microwave irradiation for efficient cellulose depolymerization into glucose

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S1. Characterization of Graphene oxide

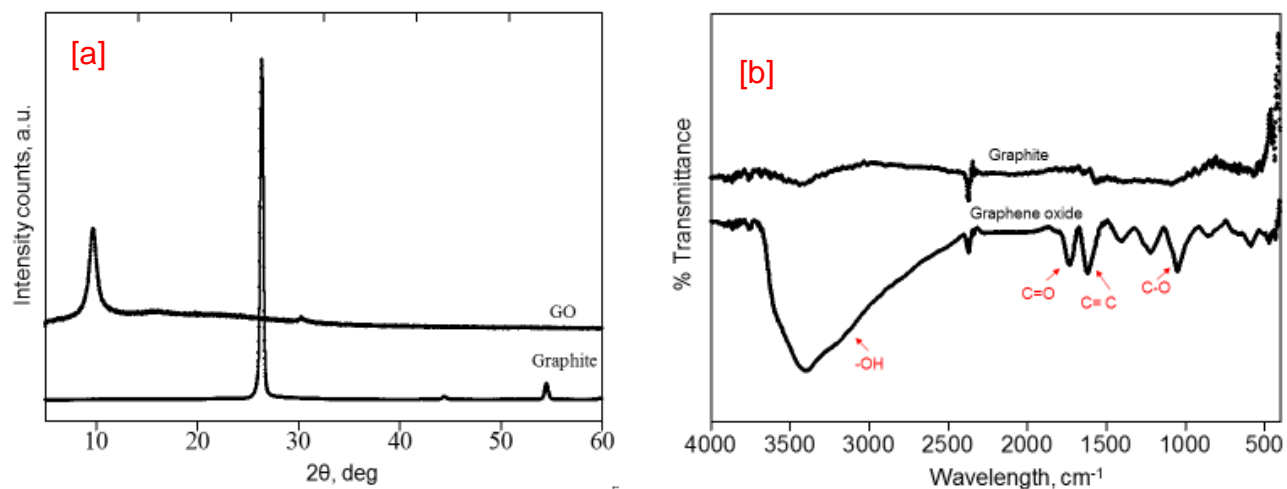


Fig. S1. (a) XRD pattern and (b) FTIR spectra of synthesized GO in comparison with graphite

Table S1: Elemental Analysis:

| | %C | %H | %O | %S |
|---------|------|-----|------|-----|
| GO | 47.9 | 2.1 | 49.3 | 0.7 |
| | 48.1 | 1.9 | 49.5 | 0.5 |
| Average | 48.0 | 2.0 | 49.4 | 0.6 |

S2. Microwave heating profiles

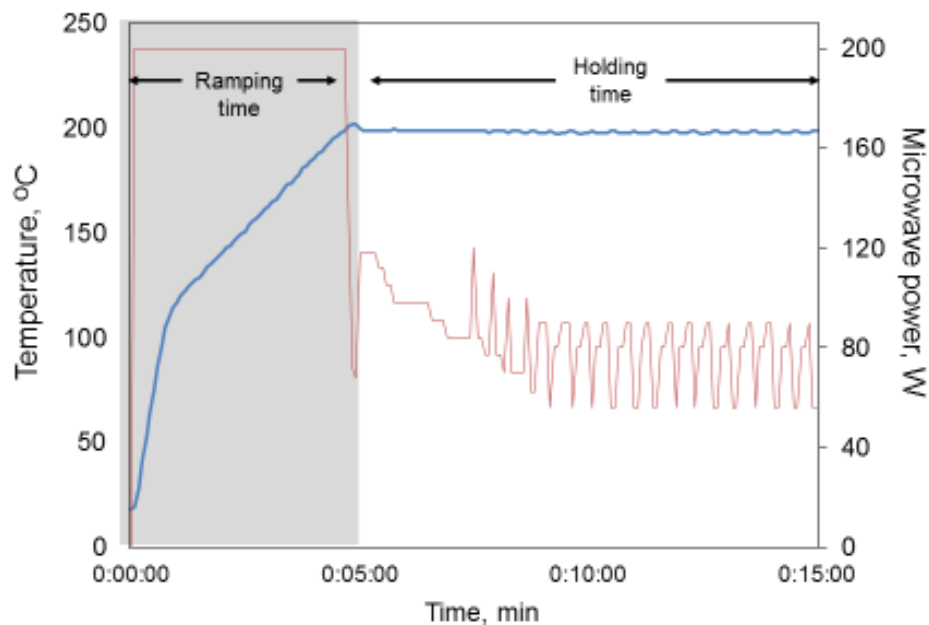


Fig. S2. Typical microwave heating profile used in the study (Ramping from room temperature to 473 K and holding for 10minutes)

S3. TRS analysis was used to validate glucose yields obtained by HPLC

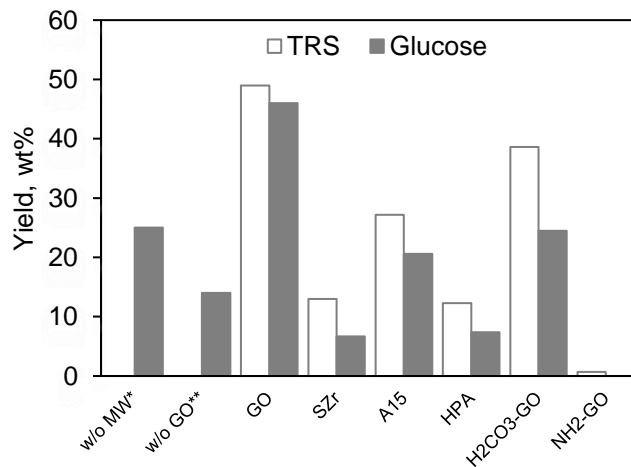


Fig. S3 Comparison of catalytic performance of GO with control experiments and selected solid acids in synergy with microwave irradiation in terms of glucose and total reducing sugars (TRS) yield. (Reaction conditions: 0.1 g MCC, 0.1 g catalyst, 10ml water, 473 K and 200 W); * - GO hydrothermal

S4. Formation of degradation products

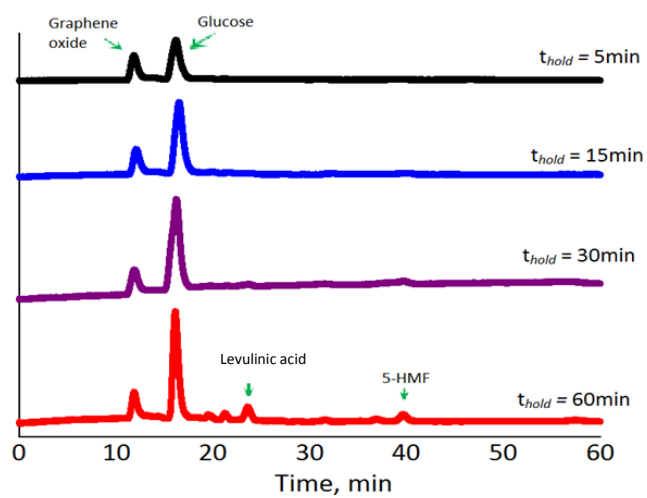


Fig. S4. HPLC Chromatograms of the hydrolysates taken at 473 K, 200W. Reaction conditions: 0.1 g Avicel, 0.1 g GO and 10ml distilled water. Retention time for Glucose ~16min; Formic acid ~ 20.6min; Levulinic acid ~23min and 5-HMF ~38.9min

S5. Post-reaction GO Characterization

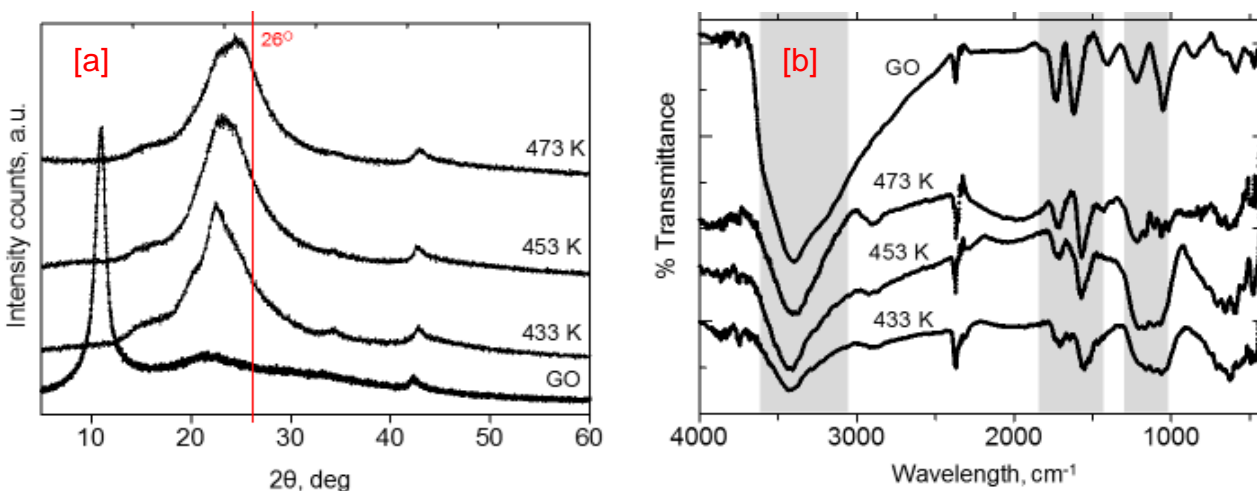


Fig. S5. (a) XRD pattern (b) FTIR spectra and of spent GO from different reaction temperatures in comparison with fresh GO

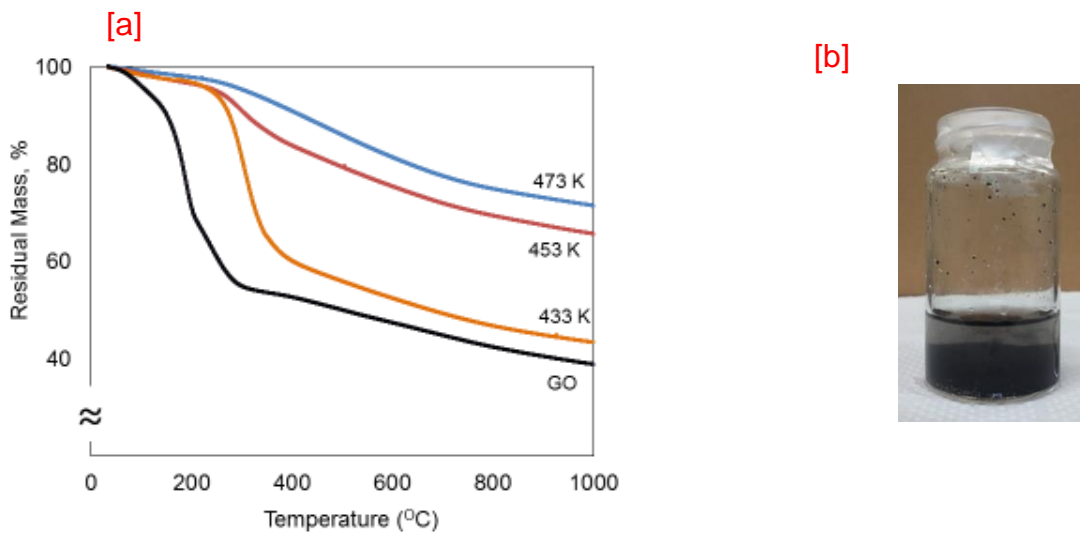


Fig. S6. (a) TGA curves of spent GO from different reaction temperatures in comparison with fresh GO (b) digital photo of spent GO re-dispersed in water showing partition between water and spent GO after several minutes indicating immiscibility

S6. Microcrystalline and ballmilled cellulose

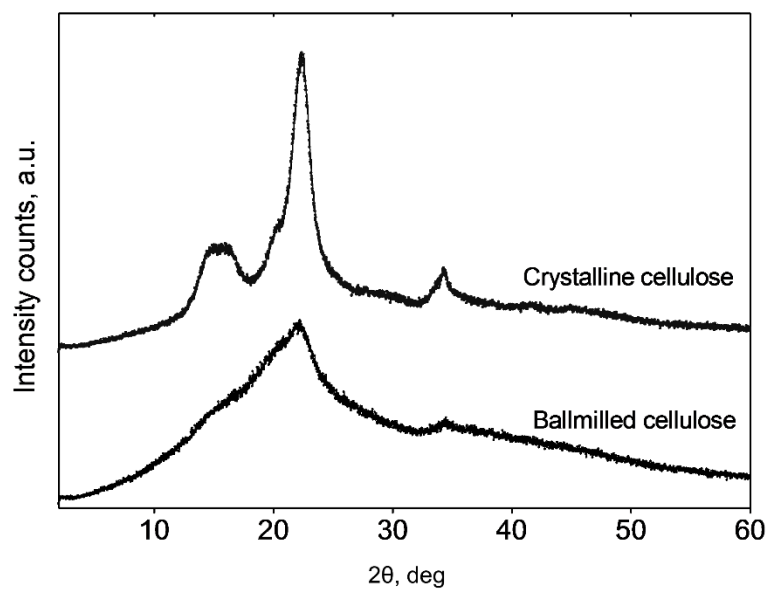


Fig. S7 XRD pattern of Avicel microcrystalline cellulose and ballmilled cellulose (conditions: 250rpm and 48hrs)

S7. Details of Control experiments

Control experiments using a microwave transferring agent (carbon nanotubes, CNT) and dilute acids (sulfuric, formic and acetic acids) were carried out to clarify the proposed depolymerization mechanism. First, the equivalent H_2SO_4 (188 μL) was derived from the 0.6% S detected by elemental analysis. Second, the amount of carbon used was around 60% based from the C1s XPS scan (data not provided). Lastly, the amount of acetic or formic acid (15 and 23 μL respectively) used was calculated from the total acidity of GO in mmol/g (average of 4 mmol/g, refer to Table 2 of the main paper). Table S2 shows the glucose yields obtained from the experiments.

Table S2. Control experiments (reaction conditions: 453 K, 60min, 200W)

| Entry | Catalyst | Dilute acid | Glucose yield (wt%) |
|-------|------------------|-------------------|---------------------|
| 1 | -- | -- | 0 |
| 2 | CNT | -- | 0 |
| 3 | CNT | sulfuric acid | 1.8 |
| 4 | CNT | formic acid | 12 |
| 5 | CNT | acetic | 7.4 |
| 6 | CNT | formic + sulfuric | 13 |
| 7 | Pre-reduced RGO* | formic + sulfuric | 18 |
| 8 | RGO | -- | 34 |

*GO was initially reduced at 453 K in the absence of cellulose

S8. RGO-cellulose mixture at elevated temperatures

Solid residues consisting of cellulose and graphene oxide after the reaction was separated from the hydrolysate through ordinary filtration, then dried for 24 h at 333 K. After drying, the mixture was mixed thoroughly and added with water. Then it was subjected to MW conditions (200 W, ramping time ~10min + holding time of 5 min).

Table S3. RGO-cellulose (reaction conditions: 200W, 5min holding time)

| Entry | Temperature, K | Glucose yield (wt%) |
|-------|----------------|---------------------|
| 1 | 493 | 13 |
| 2 | 513 | 24 |