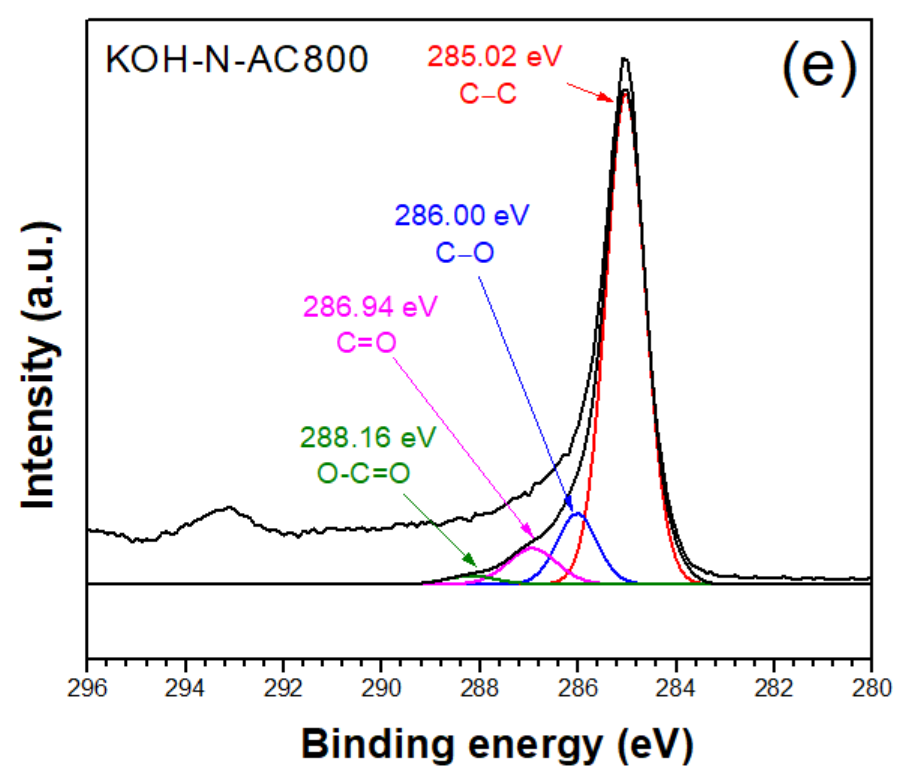
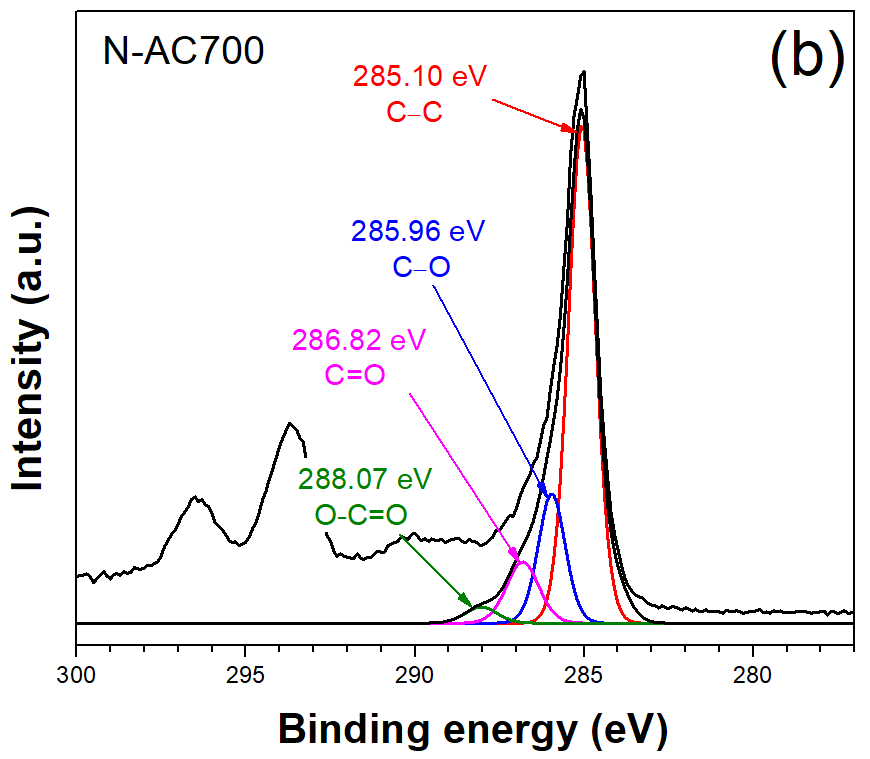
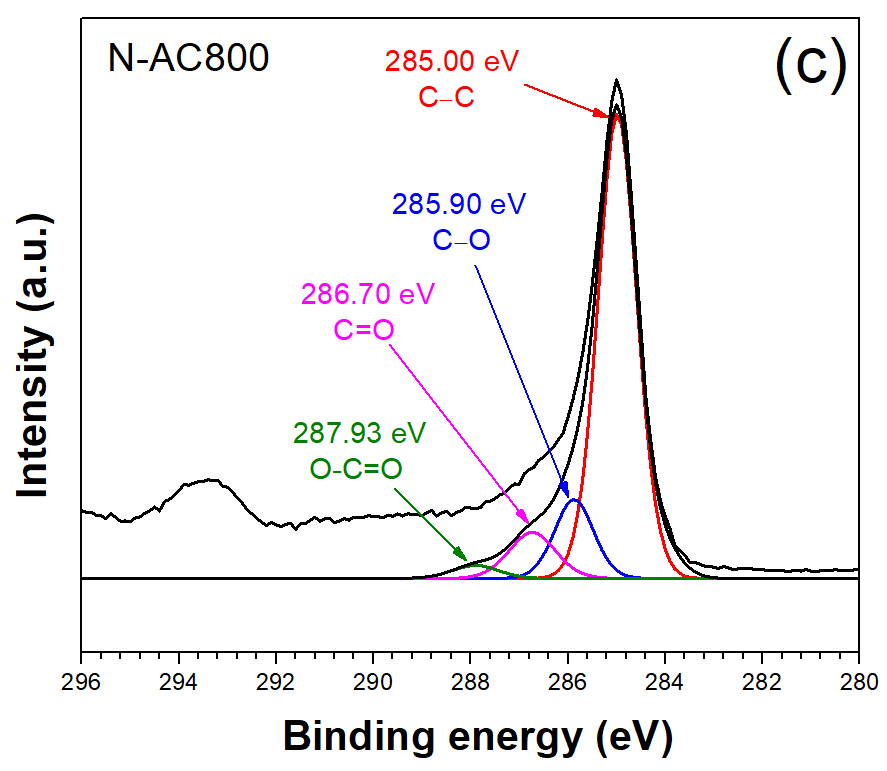
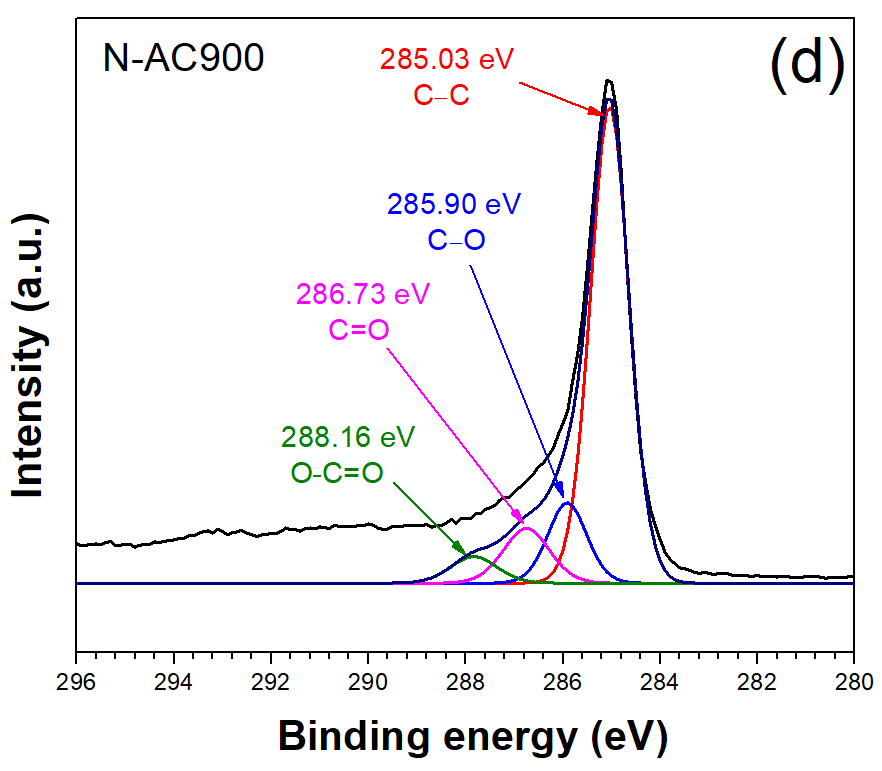
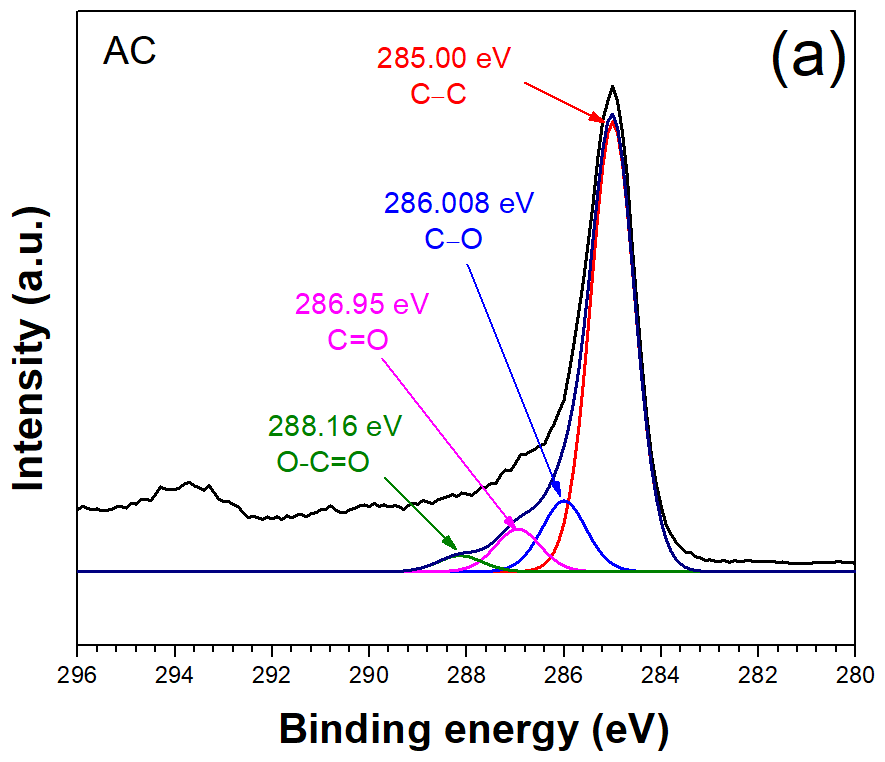
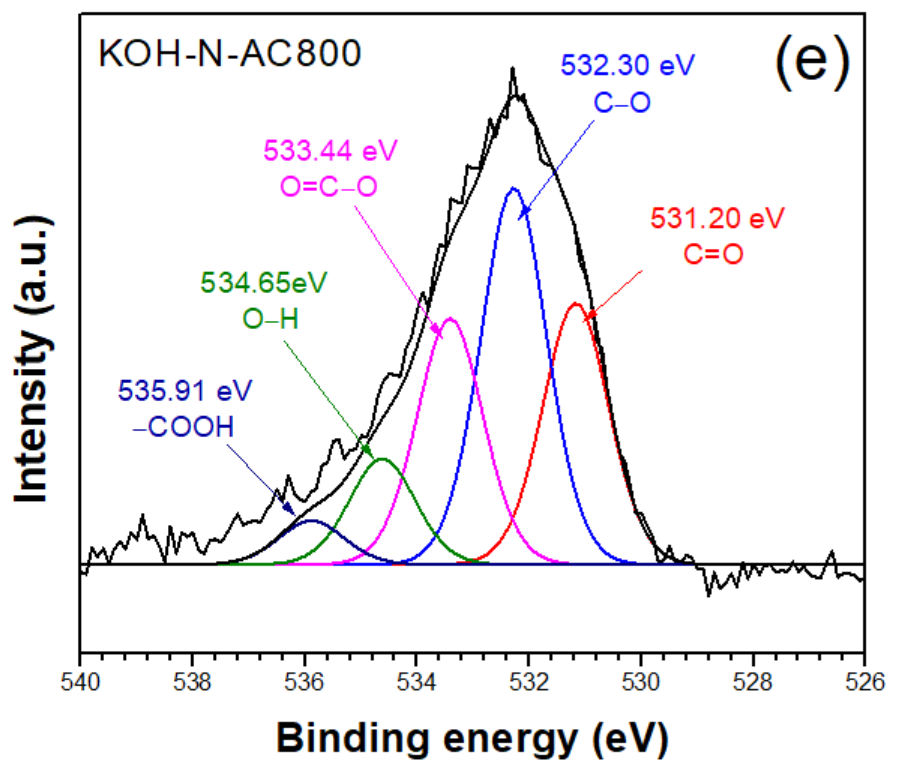
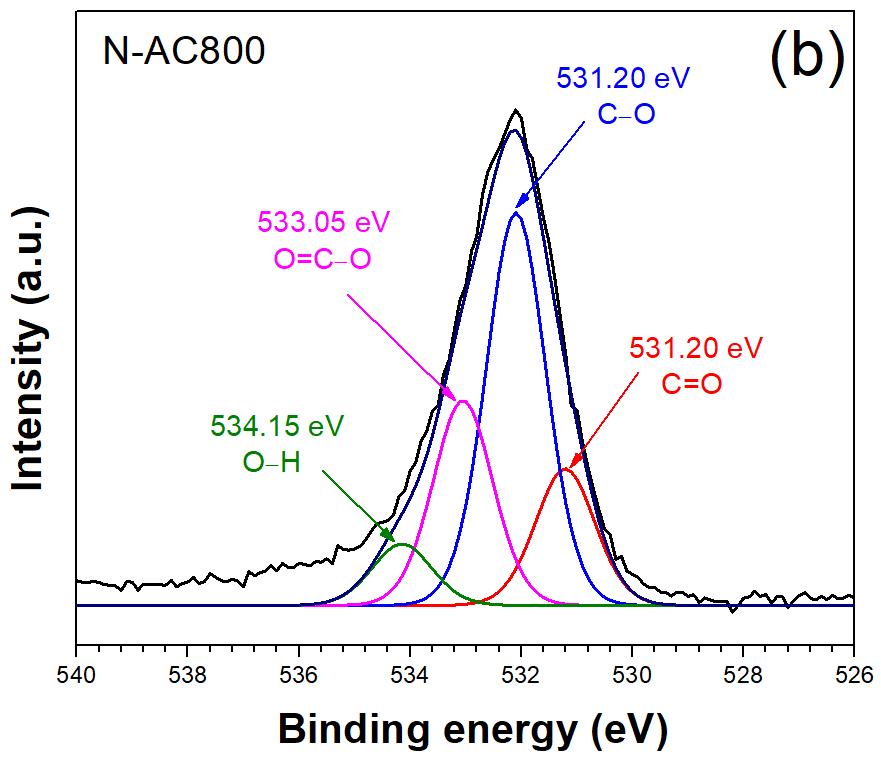
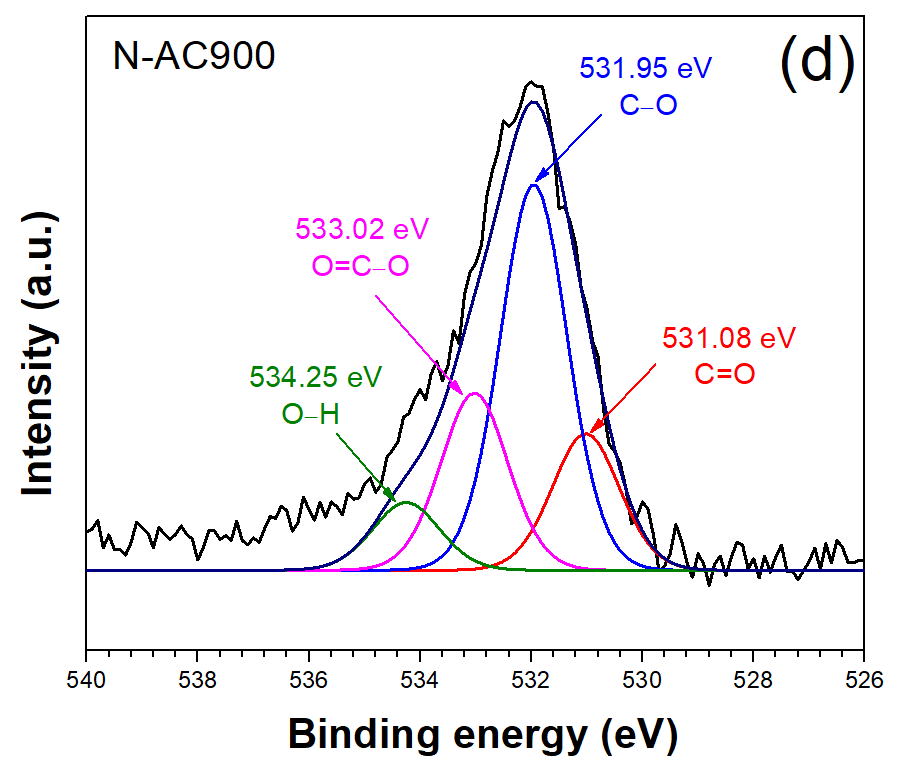
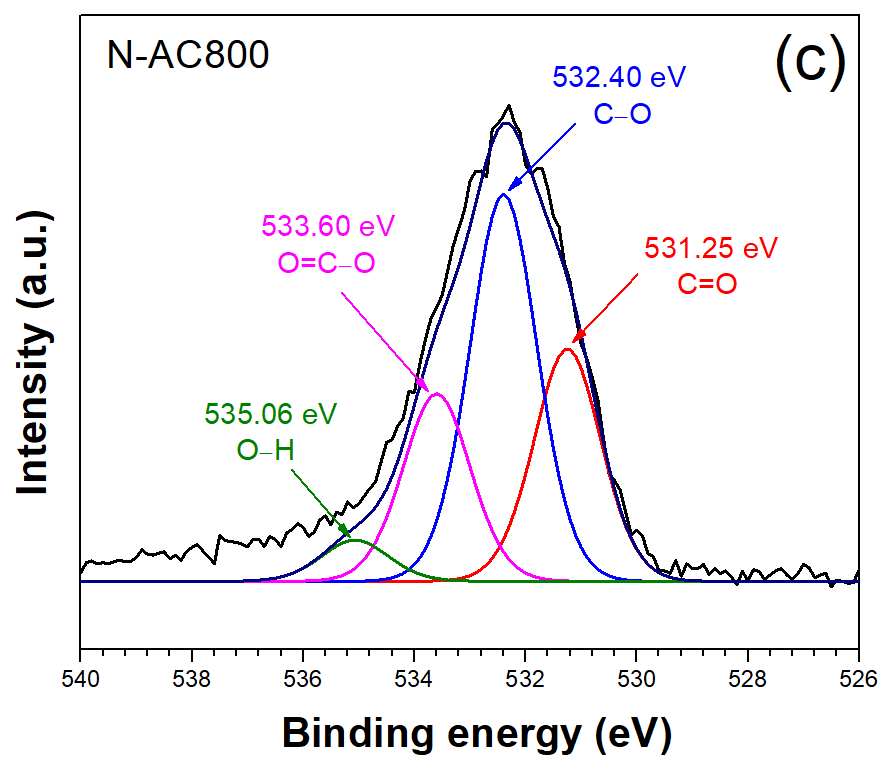
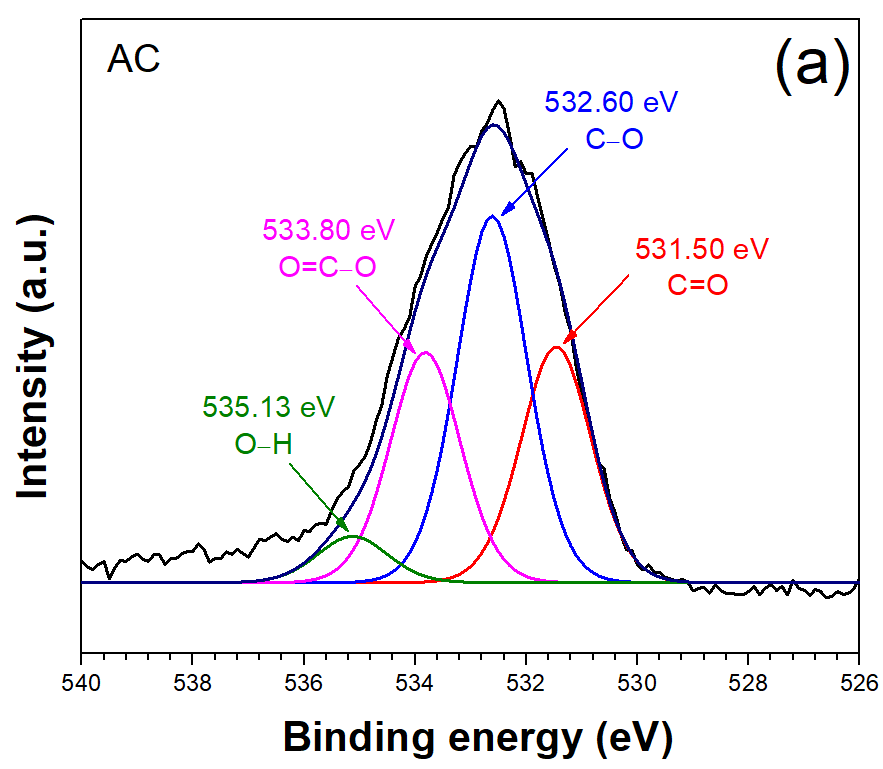
**Table S1:** SEM-EDS analysis of the element composition of AC, N-AC, KOH-AC, and KOH-N-AC

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Element (wt%)** | | | | | | | | |
|  | **Carbon** | **Oxygen** | **Sodium** | **Magnesium** | **Silicon** | **Phosphorus** | **Sulfur** | **Potassium** | **Calcium** |
| AC | 75.02 | 16.66 | 0.39 | 0.04 | 0.13 | 0.06 | 2.13 | 3.55 | 2.02 |
| N-AC700 | 80.64 | 12.89 | 0.36 | 0.09 | 0.15 | 0.05 | 1.37 | 2.6 | 1.85 |
| N-AC800 | 84.00 | 10.85 | 0.38 | 0.07 | 0.12 | 0.12 | 1.13 | 1.28 | 2.05 |
| N-AC900 | 82.88 | 12.30 | 0.32 | 0.10 | 0.22 | 0.07 | 0.85 | 0.95 | 2.30 |
| AC800 | 79.91 | 13.34 | 0.17 | 0.10 | 0.11 | 0.07 | 1.98 | 2.03 | 2.30 |
| KOH-AC800 | 65.93 | 22.07 | 0.09 | 0.09 | 0.15 | 0.05 | 1.03 | 4.70 | 5.89 |
| KOH-N-AC800 | 54.41 | 29.29 | 0.11 | 0.12 | 0.15 | 0.00 | 0.98 | 13.58 | 1.35 |



**Figure S1:** The C1s spectra of (a) AC, (b) N-AC700, (c) N-AC800, (d) N-AC900, and (e) KOH-N-AC800



**Figure S2:** The O1s spectra of (a) AC, (b) N-AC700, (c) N-AC800, (d) N-AC900, and (e) KOH-N-AC800

**Table S2:** Comparison of biomass-based carbon derived from various precursors, nitrogen content, SBET, CO2 adsorption capacity, nitrogen doping method,   
and advantages-disadvantages

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sample and biomass precursor** | **N/C ratio (at%)** | **SBET  (m2/g)** | **CO2 adsorption (mmol/g)  at 298 K and 1 Bar** | **Nitrogen doping  method** | **Advantages-disadvantages** | **Reference** |
| AC N-AC Tea seed shell | - 0.04-0.07 | 1503 706-1065 | 3.15 1.95-2.75 | Mixed with melamine and heat at 700°C for 2 h | • CO₂ adsorption is predominantly influenced by the specific surface area rather than by nitrogen doping • Low-level nitrogen doping technique  • Nitrogen-doping process employs melamine as nitrogen source. However, this method requires a purification involving hydrochloric acid, which is both time-consuming and the use of toxic chemicals | 1 |
| AC N-AC Tea seed shell | - 0.04-0.07 | 1503 706-1065 | 3.15 1.95-2.75 | Mixed with melamine and heat at 700°C for 2 h | • CO₂ adsorption is predominantly influenced by the specific surface area rather than by nitrogen doping • Low-level nitrogen doping technique  • Nitrogen-doping process employs melamine as nitrogen source. However, this method requires a purification involving hydrochloric acid, which is both time-consuming and the use of toxic chemicals | 2 |
| Commercial BAC NBAC Bamboo | N.A. 2.60-5.65 | N.A. 759-1489 | 1.43-2.21 2.49-3.52 | Mixed with sodamide and heat at 400-600°C for 2 h | • Nitrogen-doping process employs sodamide as nitrogen source. However, this method requires a purification involving hydrochloric acid, which is both time-consuming and the use of toxic chemicals | 3 |
| N-AC Macroalgae | 19.67 | 1098 | 1.86 | Mixed with KOH-melamine and heat at 800°C under  N2 for 1 h | • Nitrogen-doping process employs melamine as nitrogen source. However, this method requires a purification involving distilled water and hydrochloric, which is both time-consuming and the use of toxic chemicals | 4 |
| Mesoporous N-doped carbon Tea waste | N.A. | 162-354 | 1.37-1.74 | Heat at 800°C under N2 for 2 h | • Environmentally friendly nitrogen doping method | 5 |
| Activated biocarbon Nitrogen-doped activated biocarbon Arundo donax | 16.91 10.25-21.25 | 18 582-982 | 1.5 2.1-2.2 | Mixed with urea and KOH/ZnCl2 and heat at 600°C under N2 for 2 h | • There is no report of a purification process to remove the residual and unwanted chemicals | 6 |
| AC N-AC Brazil nut shells | 0.00 11.57-24.96 | 1748 1755-2562 | 1.32 0.94-2.49 | Separately mixed with melamine or hexamethylenetetramine (HMTA) or tetramethylamonium hydroxide (TMAOH) and heat at 700°C under N2 for 1.5 h | • Nitrogen-doping process employs melamine, HMTA and TMOH as nitrogen sources. However, this method requires a purification involving distilled water and hydrochloric, which is both time-consuming and the use of toxic chemicals | 7 |
| C NC NC-KOH  Coconut shells | 0.33 5.34 0.29-1.60 | 21 N.A. 1012-1937 | 1.5 1.4 3.7-4.8 | Mixed with urea and heat in air at 350°C. Then, KOH activation at 650°C under N2 for 1 h | • The study does not clarify whether surface area or nitrogen doping is primary factor influencing CO2 adsorption • The nitrogen content obtained in the first step significantly decreases after KOH activation in the second step | 8 |
| AC N-AC Pine sawdust | 0.06 5.58-10.27 | N.A. 363-1411 | N.A. 2.65-3.62 | Heat treatment under NH3  at 700-900°C | • NH3/Air activation at 700-900°C is a highly effective method for preparing N-AC with high CO2 adsorption capacity | 9 |
| AC N-AC KOH-N-AC Coconut shells | - 3.23-4.84 5.43 | 654 745-926 904 | 2.02 2.35-2.55 2.70 | KOH activation followed by NH3 heat treatment  at 700-900°C | • The CO2 adsorption capacity increase by 33% through hybrid KOH activation and NH3 heat treatment compared to untreated AC  • The prioritized surface treatment by KOH activation followed by NH3 heat treatment preserves the nitrogen content in KOH-N-AC, which is crucial for CO2 adsorption  • Although this work does not achieve the highest CO2 adsorption, this work demonstrates the potential of a prioritized surface treatment using KOH activation increases the surface area, followed by NH3 heat treatment that preserves the nitrogen content, both of which contribute to CO2 adsorption | This work |

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