**Supplementary Materials**

**4.1 Materials Characterization**

* + 1. **Elemental Analysis**

**Table S1** shows the elemental composition shows the difference between the raw and activated materials. The carbon content decreased from 21 wt% to 1.6 wt%, indicating KOH's strong catalyzing effect.

**Table S1: CHNS elemental composition of NMF and A-NMF.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample ID | Composition (wt.%) | | | | |
| C | H | N | S | Others (by difference) |
| NMF | 21.0 | 0.10 | 0.60 | 0.00 | 78.3 |
| A-NMF | 1.6 | 0.00 | 0.10 | 0.00 | 98.3 |

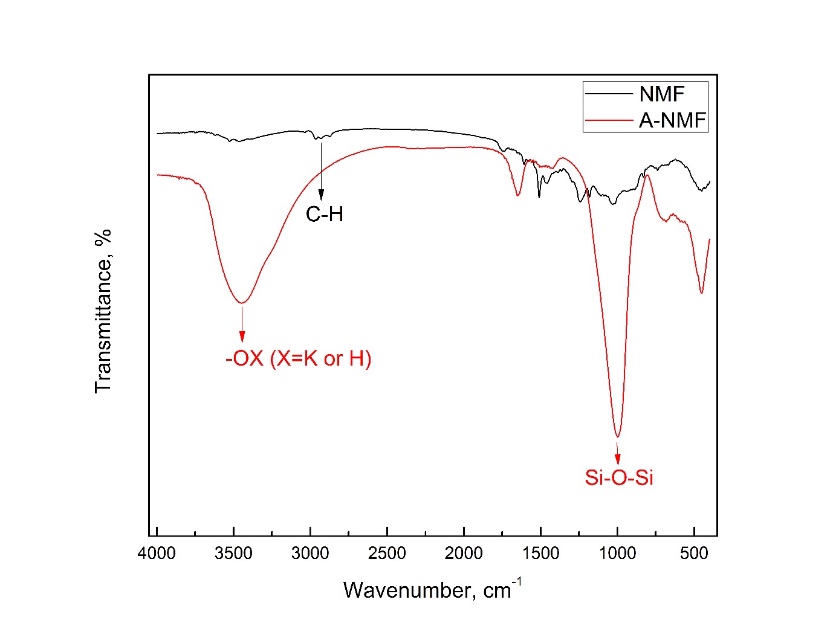
Additionally, the X-ray fluorescence spectrometry (XRF) results based on three analyses, in **Table S2**, show that the mature elements in NMF are silicon, aluminum, and calcium. Since aluminosilicate materials are thermally stable, most of the composition after the treatment remains the same. The only significant difference is in the decrease in bromide and the increase in potassium after activation; this is possibly due to the formation of potassium bromide when bromide reacts with potassium hydroxide potassium is doped on the surface as -O- K+ active groups for ion exchange.

**Table S2. Composition of major elements in NMF and A-NMF determined by XRF**

|  |  |  |
| --- | --- | --- |
| Element | Elemental Composition of NMF (mol%) | Elemental Composition of A-NMF (mol%) |
| Al | 12.1 | 10.7 |
| Si | 51.8 | 43.7 |
| Ca | 30.8 | 26.9 |
| Ti | 0.16 | 0.16 |
| Fe | 0.10 | 0.07 |
| Cu | 0.18 | 0.14 |
| Br | 4.10 | 0.00 |
| Ba | 0.06 | 0.05 |
| K | 0.00 | 17.5 |

* + 1. **Fourier transform spectroscopy (FTIR)**

**Figure S1** shows the Fourier transform infrared spectroscopy (FTIR) spectrum of NMF and A-NMF. The NMF spectrum shows a band located at 2928 cm-1 corresponding to C-H vibrations in methylene and methyl groups, and the vibrations at 1461 cm-1 correspond to C-H2 groups. These vibrations are missing in A-NMF, consistent with the elemental results showing that carbon has burnt off during the activation process. Also, A-NMF shows a robust and broad signal between 3250 cm-1 and 3550 cm-1, which indicates the presence of Si-O-X (X=K or H) functional groups. The absence of hydroxyl groups and the peak located to 1013 cm-1 in NMF reflects the cleavage of siloxane groups to form silanol groups: the dominant activation mechanism.



**Figure S1. FTIR Spectra of NMF and A-NMF**

* + 1. **N2 adsorption-desorption studies/ BET analysis**

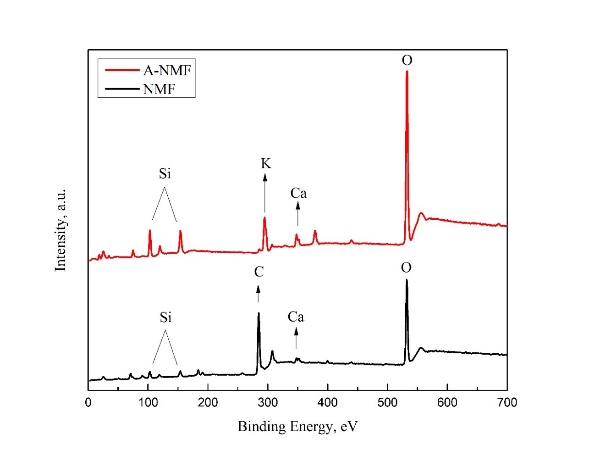
**Table S3** shows the BET analysis - surface area, volume, mesoporous volume, and total pore volume - before and after NMF material activation. The raw material before activation shows significantly less surface area (0.85 m2/g) than the after (218 m2/g), which shows that the material has successfully become mesoporous, thereby being an excellent candidate for adsorbents. Mesoporosity is reflected in the pore volume as well, where the mesoporous volume increased by 0.757 cc/g.

**Table S3. BET surface area and pore volume of NMF and A-NMF**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample | *S*BET (m2/g) | *V*micro (cc/g) | *V*meso (cc/g) | *V*total (cc/g) |
| NMF | 0.85 | 6.00 E-3 | 0.00 | 0.006 |
| A-NMF | 218 | 4.00 E-3 | 0.76 | 0.80 |

* + 1. **X-Ray Photoelectron Spectrometry (XPS)**

X-ray photoelectron spectroscopy (XPS) was used to investigate the surface functional moieties developed on the A-NMF upon activation (see **Figure S2**). **Table S4** shows a summary of the binding energies and corresponding elements and mass in both samples. The spectra show significant differences in chemical composition between the raw and activated material. The peak at 292 eV for A-NMF confirms the creation of potential ion-exchange sites to K 2p bands. Additionally, the significant decrease in C spectra is probably due to the conversion of all impurities to CO2 during activation due to high temperatures – the reduction agrees with the FTIR and elemental analysis.



**Figure S2: XPS spectrum of NMF and A-NMF.**

Furthermore, the significant increase in oxygen spectra (530 eV) shows that they come to the surface during the reaction as *Si*-*O*-­*Ca* or *Si*-*O*-K groups. The surface areas increase due to the siloxane functional groups' cleavage, which results in more oxygen atoms, either as unreacted siloxane groups or reacted silanol. This justification applies to the increase in potassium, silicon, and calcium on the activated surface of A-NMF.

**Table S4. Surface composition of NMF and A-NMF determined by XPS**

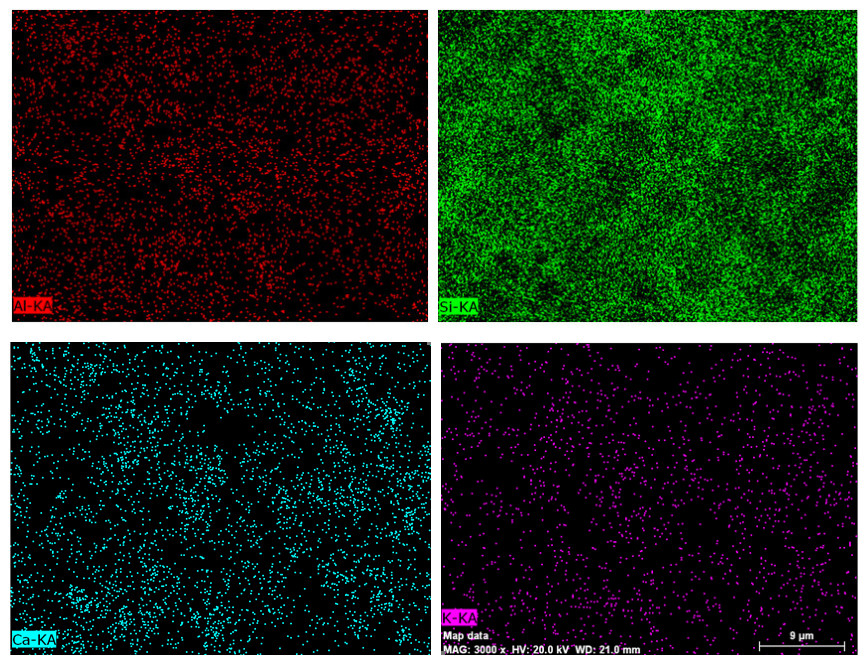
|  |  |  |  |
| --- | --- | --- | --- |
| **Element** | **Binding Energy (eV)** | **% mass** | |
| NMF | A-NMF |
| Si (2p) | 102.5 | 9.48 | 23.19 |
| C (1s) | 285 | 48.01 | 2.22 |
| K (2p) | 293.8 | 0 | 12.16 |
| Ca (2p) | 347.4 | 0.95 | 7.4 |
| O (1s) | 531.7 | 30.46 | 47.9 |
| Al (2s) | 119.2 | 3.84 | 4.8 |

* + 1. **Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM-EDX)**

**Figure S3** shows the SEM images of NMF (a) and A-NMF (b). The images clearly show the NMF composed of random glass fibers with carbonaceous materials on the surface compared to amorphous A-NMF with potassium. The thermo-alkaline reaction is confirmed from the images that changed the non-porous NMF to porous clusters of A-NMF. The SEM EDX elementary mapping shows the amorphous properties of the activated material and the potassium on the material's surface.

**Figure S3: SEM images of (a) raw material (NMF) and (b) activated material (A-NMF)**



**Figure S4. SEM image and SEM-EDX elementary mapping**