**Extraction and characterization of highly pure alumina (α, γ, and θ) polymorphs from waste beverage cans: A viable waste management approach**

Md. Lutfor Rahmana,⁎, Md. Sydul Islamb, Md. Farid Ahmeda, Bristy Biswasa, Nahid Sharmina, A J M Tahuran Negera

aInstitute of Glass and Ceramic Research and Testing (IGCRT), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh

bDepartment of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

**\*Corresponding Author:** Md. Lutfor Rahman

Senior Scientific Officer (SSO)

Institute of Glass and Ceramic Research and Testing (IGCRT),

Bangladesh Council of Scientific and Industrial Research (BCSIR),

Dhaka-1205, Bangladesh

Mobile: +880-1712459524

E-mail: [lutforrahman@bcsir.gov.bd](mailto:lutforrahman@bcsir.gov.bd), [lutforju33@yahoo.com](mailto:lutforju33@yahoo.com);

lutforju33@gmail.com

|  |  |
| --- | --- |
| **PAGE** | **CONTENT** |
| S3 | Compositional analysis of waste beverage cans (WBCs) |
| S4-S6 | Detailed structural results of alumina |
| S7 | Pore size distribution of alumina |

Table S1. WDXRF reports of different brands waste beverage can.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analyte** | **Composition (%)** | | | | | | | | | |
|  | **Fanta** | **Speed** | **RC Cola** | **Diet Coke** | **Mountain Dew** | **Sprite** | **Pepsi** | **7up** | **Coca-Cola** | **Mirinda** |
| Mg | 0.88 | 0.533 | 0.92 | 0.62 | 0.463 | 0.55 | 0.58 | 0.62 | 0.72 | 1.03 |
| Al | 95.98 | 94.041 | 95.3 | 95.3 | 92.1 | 94.9 | 93.8 | 94.9 | 94.8 | 95.15 |
| Si | 0.354 | 0.392 | 0.55 | 0.27 | 0.282 | 0.331 | 0.28 | 0.362 | 0.439 | 0.4 |
| P | - | - | - | 0.05 | 0.213 | 0.061 | 0.11 | 0.05 | 0.066 | - |
| S | 0.027 | 0.04 | 0.027 | 0.016 | 0.062 | 0.02 | 0.064 | 0.033 | 0.04 | 0.03 |
| Cl | 0.116 | - | 0.214 | 0.161 | 0.61 | 0.214 | 0.47 | 0.29 | 0.327 | 0.34 |
| Cr | - | - | 0.062 | 0.024 | 2.91 | 0.032 | 0.01 | 0.031 | 0.032 | - |
| Mn | 1.44 | 2.542 | 1.27 | 1.65 | 1.36 | 1.76 | 2.31 | 1.72 | 1.73 | 1.4 |
| Fe | 0.634 | 1.304 | 0.88 | 0.78 | 0.014 | 0.95 | 1.15 | 0.79 | 0.96 | 0.89 |
| Ni | - | - | 0.03 | 0.011 | 0.583 | 0.019 | 0.02 | 0.012 | 0.031 | 0.02 |
| Cu | 0.293 | 0.66 | 0.31 | 0.4 | 1.12 | 0.49 | 0.49 | 0.413 | 0.436 | 0.339 |
| Zn | 0.021 | 0.452 | 0.16 | 0.65 | 0.05 | 0.567 | 0.491 | 0.62 | 0.304 | 0.14 |
| Others | 0.255 | 0.036 | 0.277 | 0.068 | 0.233 | 0.106 | 0.225 | 0.159 | 0.115 | 0.261 |

**Table S2. Detailed XRD results of alumina samples calcined at different temperatures**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Calcination temp. (℃)** | **2θ (º) position**  **(experimental)** | **2θ (º) value**  **(ICCD card)** | **Phase composition** | **Lattice**  **plane (*hkl*)** | **ICCD PDF card no.** |
| **280** | 18.7182 | 18.8250 | Bayerite | 001 | 00-020-0011 |
| 28.2049 | 28.1807 | Boehmite | 120 | 00-021-1307 |
| 37.8260 | 37.772 | γ-Al2O3 | 103 | 01-074-4629 |
| 45.8805 | 45.7884 | " | 131 | " |
| 49.0162 | 48.9290 | Boehmite | 051 | 00-021-1307 |
| 55.4106 | 55.4392 | Bayerite | 310 | 00-020-0011 |
| 60.5138 | 60.5884 | Boehmite | 051 | 00-021-1307 |
| 66.7021 | 66.651 | γ-Al2O3 | 224 | 01-074-4629 |
| **340** | 18.6285 | 18.8250 | Bayerite | 001 | 00-020-0011 |
| 28.1161 | 28.1807 | Boehmite | 120 | 00-021-1307 |
| 37.8568 | 37.772 | γ-Al2O3 | 103 | 01-074-4629 |
| 45.7917 | 45.7884 | " | 131 | " |
| 48.9855 | 48.9290 | Boehmite | 051 | 00-021-1307 |
| 66.6523 | 66.651 | γ-Al2O3 | 224 | 01-074-4629 |
| **500** | 37.3957 | 37.335 | " | 211 | " |
| 45.7167 | 45.347 | " | 220 | " |
| 66.6776 | 66.651 | " | 224 | " |
| **700** | 37.5023 | 37.335 | " | 211 | " |
| 39.4093 | 39.215 | " | 202 | " |
| 45.6499 | 45.347 | " | 220 | " |
| 66.9082 | 66.651 | " | 224 | " |
| **900** | 19.4859 | 19.537 | θ-Al2O3 | -201 | 00-023-1009 |
| 31.4006 | 31.509 | " | -401 | " |
| 32.8085 | 32.778 | " | 002 | " |
| 34.9229 | 34.939 | " | -111 | " |
| 36.7915 | 36.743 | " | 111 | " |
| 38.8812 | 38.871 | " | 401 | " |
| 39.8623 | 39.911 | " | 202 | " |
| 44.9354 | 44.856 | " | -112 | " |
| 47.4219 | 47.585 | " | 600 | " |
| 50.6927 | 50.680 | " | 510 | " |
| 60.0304 | 59.914 | " | -313 | " |
| 62.4276 | 62.339 | " | 113 | " |
| 64.1432 | 64.050 | " | 020 | " |
| 67.3613 | 67.401 | " | 403 | " |
| **1000** | 19.5037 | 19.537 | " | -201 | " |
| 31.3548 | 31.509 | " | -401 | " |
| 32.7536 | 32.778 | " | 002 | " |
| 34.8440 | 34.939 | " | -111 | " |
| 36.7039 | 36.743 | " | 111 | " |
| 38.7944 | 38.871 | " | 401 | " |
| 39.8397 | 39.911 | " | 202 | " |
| 44.9429 | 44.856 | " | -112 | " |
| 47.5098 | 47.585 | " | 600 | " |
| 50.5226 | 50.680 | " | 510 | " |
| 56.6964 | 56.722 | " | 203 | " |
| 59.9451 | 59.914 | " | -313 | " |
| 62.3737 | 62.339 | " | 113 | " |
| 64.0338 | 64.050 | " | 020 | " |
| 67.3693 | 67.401 | " | 403 | " |
| **1200** | 25.6087 | 25.5835 | α-Al2O3 | 0 1 2 | 00-010-0173 |
| 35.2120 | 35.1356 | " | 1 0 4 | " |
| 38.0027 | 37.7837 | " | 1 1 0 | " |
| 43.4199 | 43.3620 | " | 1 1 3 | " |
| 52.7361 | 52.5512 | " | 0 2 4 | " |
| 57.4761 | 57.5177 | " | 1 1 6 | " |
| 61.3953 | 61.3435 | " | 0 1 8 | " |
| 66.6484 | 66.5465 | " | 2 1 4 | " |
| 68.2079 | 68.1962 | " | 3 0 0 | " |

 

**Figure S1. Pore size distribution curves of the prepared alumina samples calcined at different temperatures of 500, 700, 900, 1000 and 1200 ℃, respectively.**