Supplementary Materials

Ambient, Two-Step CO_2-to-$CaCO_3$ Conversion: Alkali-Activated H_2O_2-Promoted Carbonate CO_2 Capture and Direct Calcite Mineralization

Eugene Shirman[a],* and **Yoel Sasson**[a]

[a] Casali Center of Applied Chemistry, Institute of Chemistry, The Hebrew University of Jerusalem, Jerusalem, 9190401, Israel

*Corresponding author: eugene.shirman@mail.huji.ac.il

ORCID: Eugene Shirman 0000-0002-4702-9578; Yoel Sasson 0000-0002-0701-681X

Table of Contents

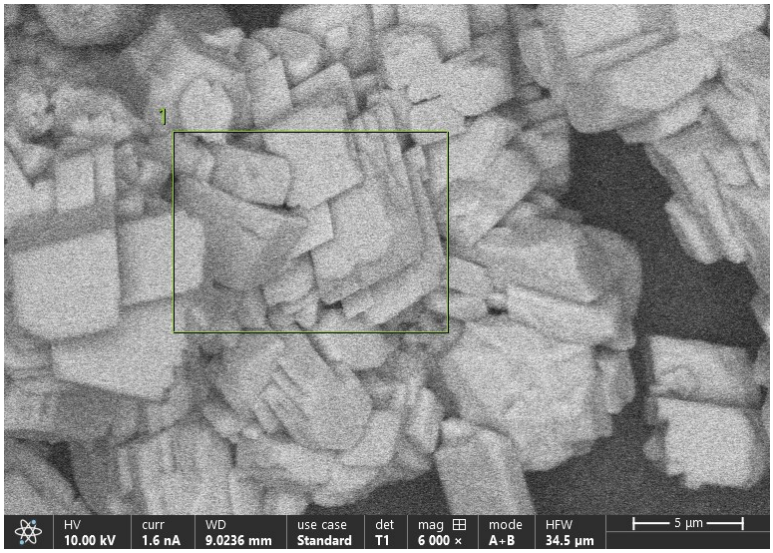

Figure S1: SEM image of $CaCO_3$ from 7 wt% Na_2CO_3 + 0.7 wt% H_2O_2 liquor.

Table S1. EDS composition of $CaCO_3$ from 7 wt% Na_2CO_3 + 0.7 wt% H_2O_2 liquor.

Element	Line	At. %	Wt. %	Net Counts	At. % Error	Wt. % Error
C	K	7.0	3.8	72,528	0.0	0.0
O	K	66.0	47.6	214,622	0.3	0.2
Ca	K	27.0	48.6	280,804	0.1	0.2

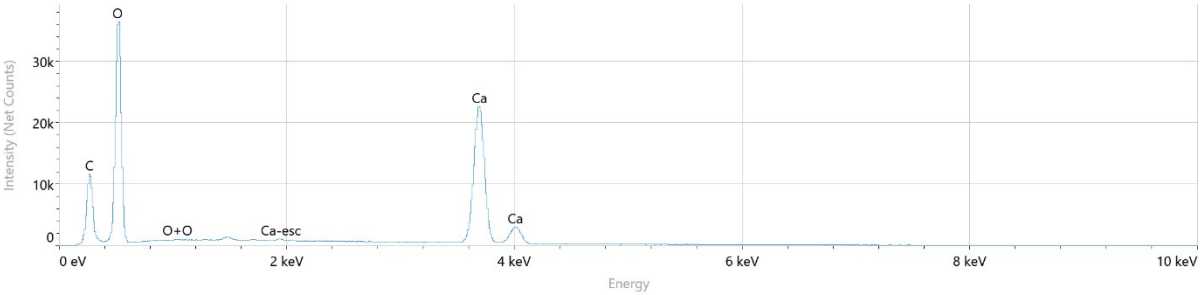

Figure S2: EDS spectrum corresponding to $CaCO_3$ from 7 wt% Na_2CO_3 + 0.7 wt% H_2O_2 liquor.

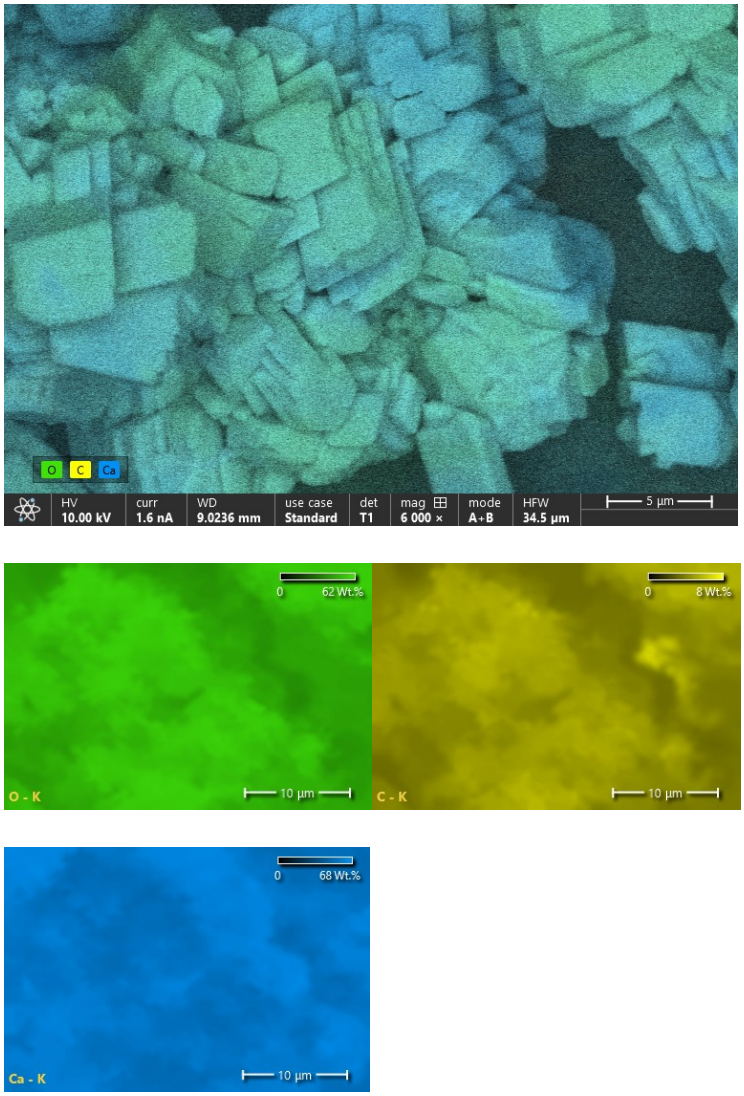

Figure S3: Elemental mapping of $CaCO_3$ from 7 wt% Na_2CO_3 + 0.7 wt% H_2O_2 liquor (from SEM analysis)

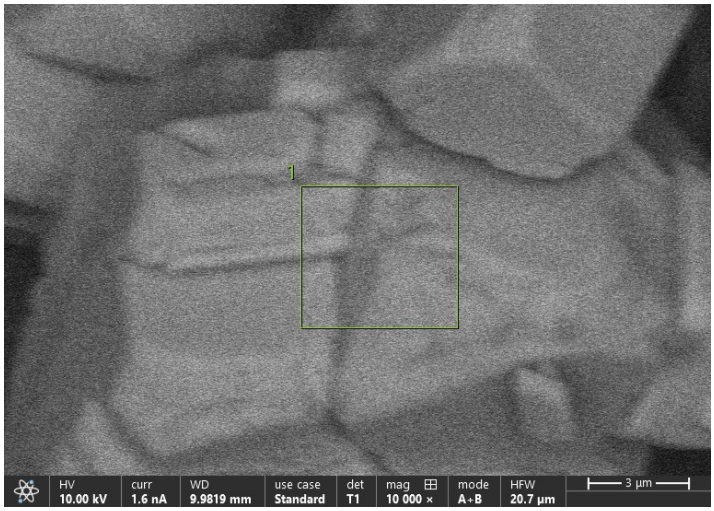

Figure S4: SEM image of $CaCO_3$ from 25 wt% K_2CO_3 + 2.5 wt% H_2O_2 liquor.

Table S2: EDS composition of $CaCO_3$ from 25 wt% K_2CO_3 + 2.5 wt% H_2O_2 liquor.

Element	Line	At. %	Wt. %	Net Counts	At. % Error	Wt. % Error
C	K	9.1	5.1	124,548	0.0	0.0
O	K	66.4	49.3	294,910	0.3	0.2
Ca	K	24.5	45.6	326,903	0.1	0.2

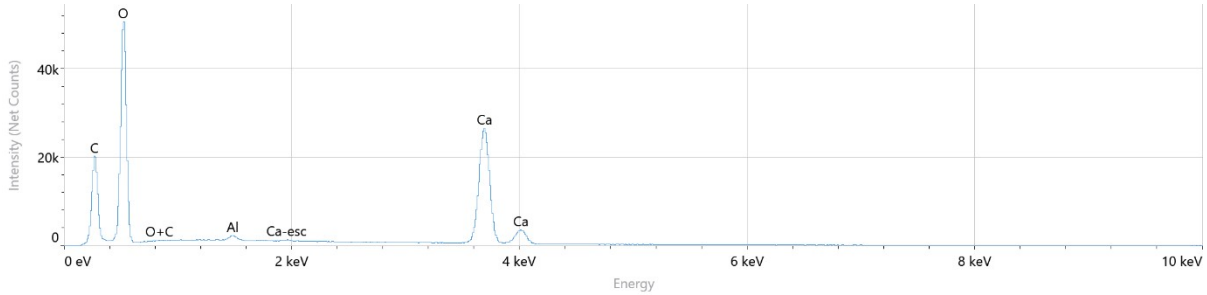

Figure S5: EDS spectrum corresponding to $CaCO_3$ from 25 wt% K_2CO_3 + 2.5 wt% H_2O_2 liquor.

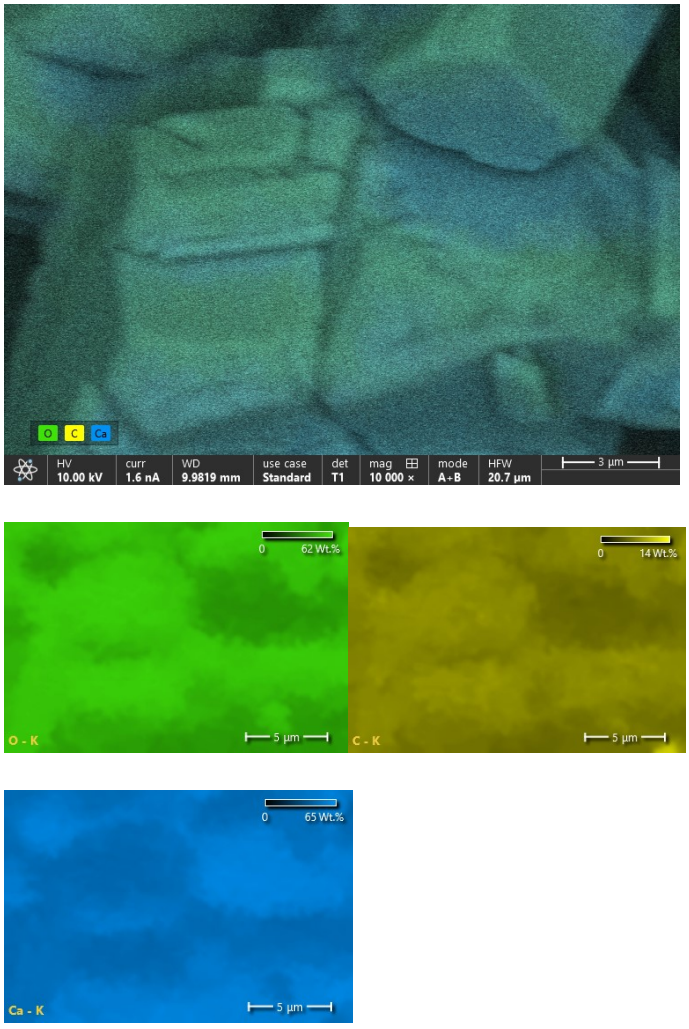

Figure S6: Elemental mapping of $CaCO_3$ from 25 wt% K_2CO_3 + 2.5 wt% H_2O_2 liquor (from SEM analysis)

Table S3. Regional consumables price decks used for LCOC calculations (Q3 2025, USD t^{-1})

Region	Na_2CO_3	K_2CO_3	$CaCl_2$	H_2O_2 (100%)
US	280	859	330	1,639
EU	372	1,584	235	1,087
Northeast Asia	263	1,161	150	770
Southeast Asia	248	1,060	239	965

References for Table S3 IMARC Group, *Soda Ash Prices Show Strong Recovery After Q2 Decline: What's Next for the Market?*, https://www.imarcgroup.com/soda-ash-pricing-report, (accessed March 2026). IMARC Group, *Potassium Carbonate Price Index, Chart, Trend & Forecast*, https://www.imarcgroup.com/potassium-carbonate-pricing-report, (accessed March 2026). IMARC Group, *Calcium Chloride Prices, Index, Trend 2025 and Forecast*, https://www.imarcgroup.com/calcium-chloride-pricing-report, (accessed March 2026). PriceWatch, *PriceWatch, Calcium Chloride Price Trend and Forecast*, https://www.price-watch.ai/calcium-chloride-prices, (accessed March 2026). ChemAnalyst, *Hydrogen Peroxide Prices, Trend, Chart, News and Forecast*, https://www.chemanalyst.com/Pricing-data/hydrogen-peroxide-1169, (accessed March 2026). PriceWatch, *PriceWatch, Hydrogen Peroxide Price Trend and Forecast*, https://www.price-watch.ai/hydrogen-peroxide-prices, (accessed March 2026).

Table S4. Utilization factors, u, used for LCOC calculations.

Formulation	Spec	Utilization, u
Na_2CO_3 7 wt%	90%	0.875
Na_2CO_3 7 wt%	95%	0.788
Na_2CO_3 10 wt%	90%	0.525
Na_2CO_3 10 wt%	95%	0.450
K_2CO_3 20 wt%	90%	0.900
K_2CO_3 20 wt%	95%	0.875
K_2CO_3 25 wt%	90%	0.700
K_2CO_3 25 wt%	95%	0.663

Common assumptions.

- Mass ledger (per tCO_2): Na_2CO_3 2.408 t; K_2CO_3 3.140 t; $CaCl_2$ 2.522 t; $CaCO_3$ 2.274 t.
- Regional price decks were compiled from source-reported market benchmarks.
- Country-level prices were used as regional proxies where regional averages were unavailable.
- For price decks lacking direct Q3 2025 quotations, Q3 2025 values were back-calculated from reported December 2025 prices and the corresponding source-reported September–December change.
- H_2O_2 term: 0.10 × carbonate mass (normalized to 100%), included as non-zero.
- Specification mapping:

  $$u(95\%) = \frac{1}{2}[u(90\%) + u(100\%)]$$

- No coproduct credits. Totals rounded to nearest dollar; component sums may differ by ±1 USD due to rounding.