Electronic Supplementary Material (ESI) for Materials Advances.

Supplementary Information

Flame spheroidisation of dense and porous $Ca_2Fe_2O_5$ microspheres

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1.0 Structural Analysis

Complementary XRD investigations were performed to establish the crystalline structures of the Fe_3O_4 and $CaCO_3$ powders, both pre and post FS-processing, to clarify the structural transformations of these materials when processed individually (Figure S1). The structures of the starting materials were confirmed as Fe_3O_4 and $CaCO_3$ (Figures S1c and S1d, respectively). FS-processed magnetite powders (in the form of solid microspheres from SEM observations) were found to remain predominantly as Fe_3O_4, with some evidence for the development of trace amounts of Fe_2O_3 (Figure S1a). FS-processed porogen exhibited diffraction peaks attributable to both $CaCO_3$ and CaO (Figure S1b).

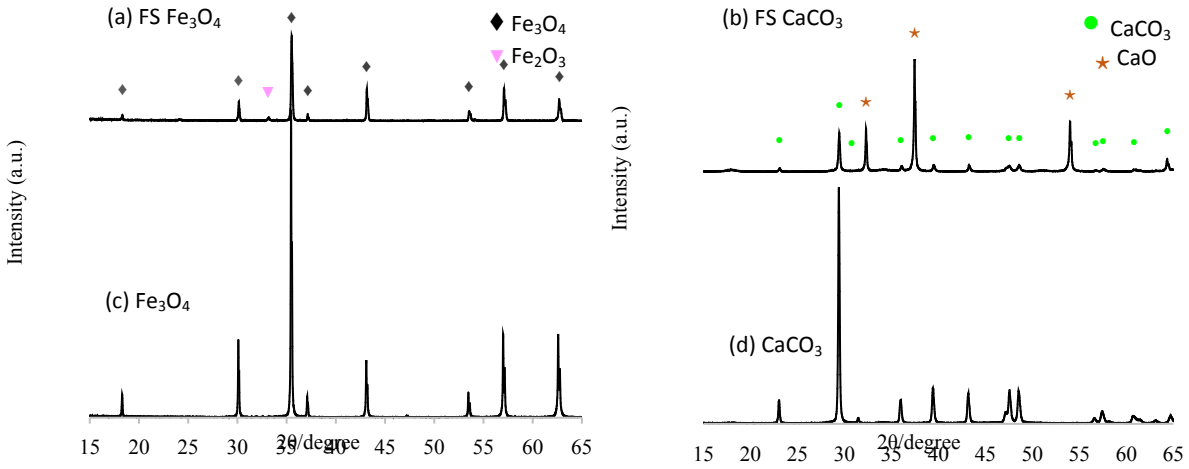

Fig. S1. XRD data for: (a) FS-processed Fe_3O_4; (b) FS-processed $CaCO_3$;(c) Fe_3O_4 starting powder; and (d) $CaCO_3$ starting porogen

2.0 Magnetic expression

A simple experiment using a magnet confirmed the sieved FS-processed $Ca_2Fe_2O_5$ products to indeed be magnetic (Figure S2).

Fig. S2. Magnet placed next to FS-processed Fe_3O_4:$CaCO_3$, following sieving, demonstrating the $Ca_2Fe_2O_5$ microsphere products to be magnetic.

3.0 Mineral Mapping

Table S1. Mineral reference

Mineral	Ca%	Fe%	O%
$Ca_2Fe_2O_5$ (srebrodolskite)	19.1	57	23.9
Fe_3O_4	-	72.4	27.64
Compound 1	3.6	73.8	22.6
Compound 2	9.6	67.3	23.1
Compound 3	15.1	61.3	23.6
Compound 4	48.4	28.9	22.6

Table S2. Modal minerology

Mineral	Particles	Weight %
$Ca_2Fe_2O_5$ (srebrodolskite)	1501	**99.75**
Fe_3O_4	5	0.01
Compound 1	2	0.01
Compound 2	3	0.01
Compound 3	24	0.08
Compound 4	25	0.14
Unknown	46	0.00

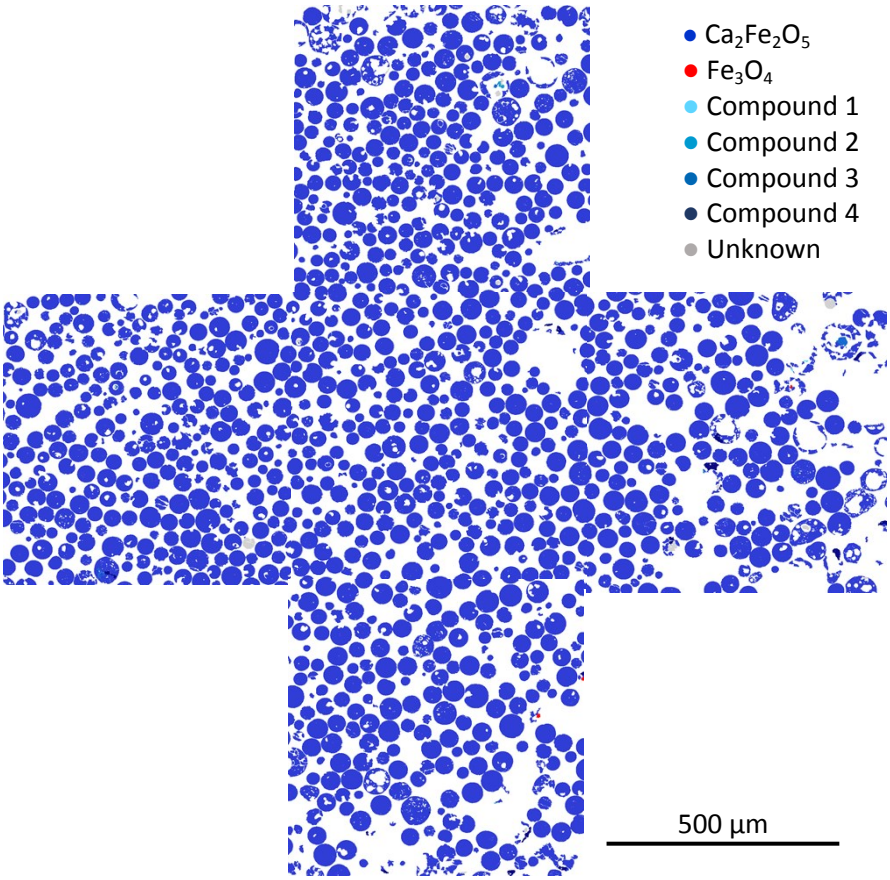

Fig. S3. Full MLA compositional analysis of FS-processed Fe_3O_4:$CaCO_3$, following sieving and sectioning, demonstrating very high levels of $Ca_2Fe_2O_5$, along with very low levels of related CaFeO phases and Fe_3O_4.

4.0 Products before and after FS

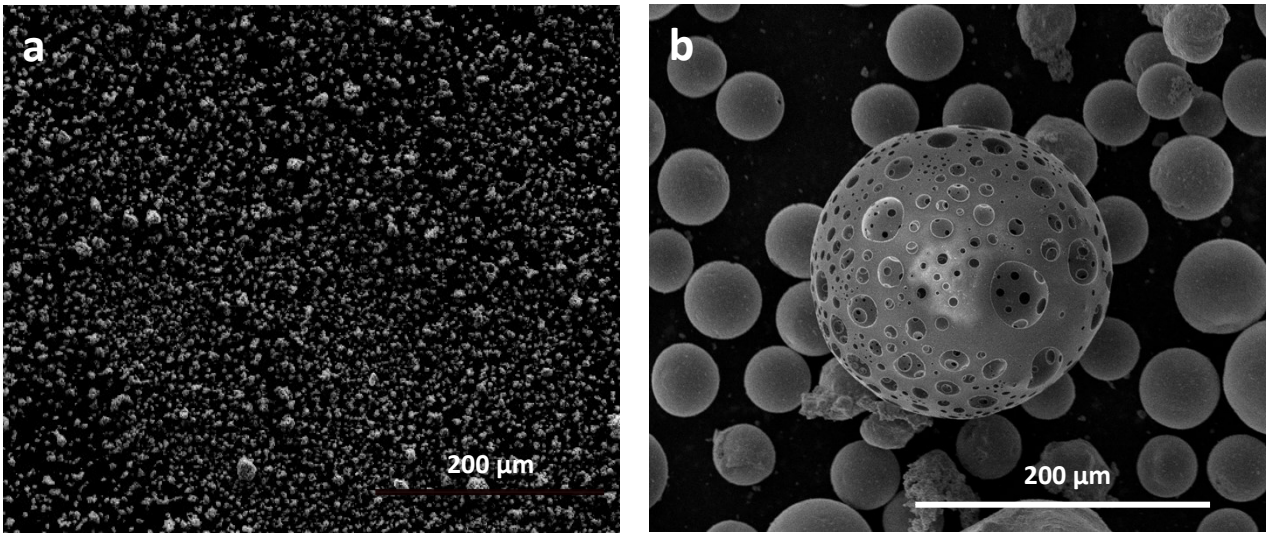

Fig. S4. a) Prepared Fe_3O_4 / $CaCO_3$ mixture with PVA. Powder used for both FS and HT-XRD analysis; b) $Ca_2Fe_2O_5$ porous microsphere (centre) and dense microspheres (background) after FS processing.

5.0 Surface analysis

Complementary X-ray photoelectron spectroscopy (VG ESCALab Mark II X-ray Photoelectron and Scanning Auger Spectrometer; Al Kα source; 20 mA; 20 kV; step 1; No. of scans 2; dwell 0.2; pass energy 50 eV, Constant Analyser Energy mode) study was performed to analyse the surface chemistry of the FS-processed $Ca_2Fe_2O_5$ porous and dense microspheres. Figure S5 presents a survey spectra of the srebrodolskite microspheres.

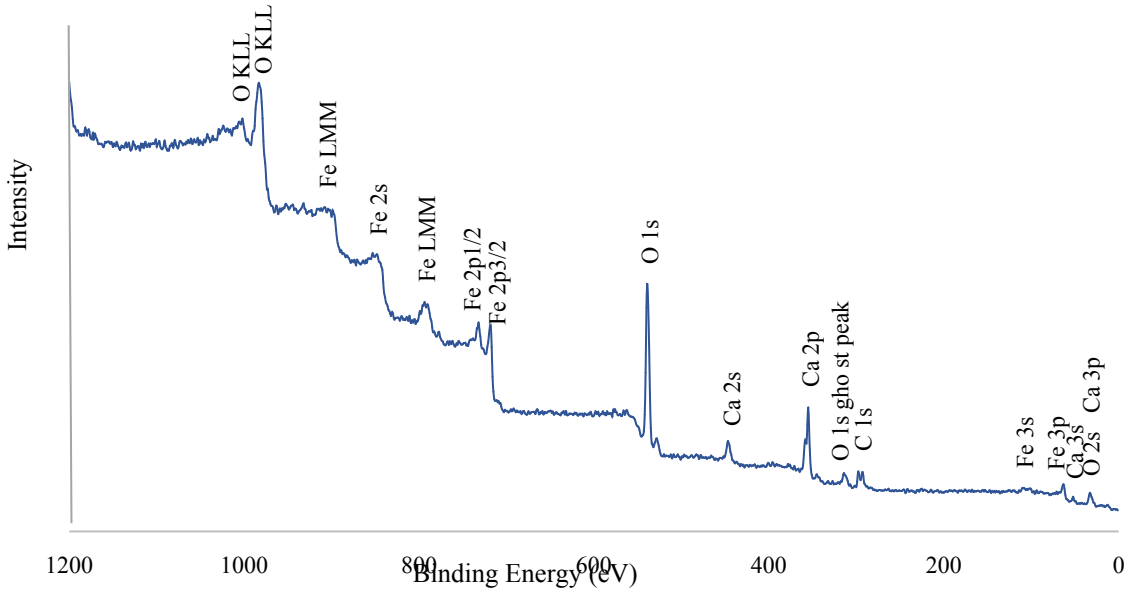

Fig. S5. XPS of FS-processed $Ca_2Fe_2O_5$ porous and dense microspheres.