

Supporting file

## Preparation of chitosan/Poly (vinyl alcohol) nanocomposite films incorporated with oxidized carbon nano-onions (multi-layer fullerenes) for tissue engineering applications

Carlos David Grande Tovar<sup>1</sup>, Jorge Iván Castro<sup>2</sup>, Carlos Humberto Valencia<sup>3</sup>, Diana Paola Navia Porras<sup>4</sup>, José Hermínsul Mina Hernández<sup>5\*</sup>, Mayra Eliana Valencia<sup>5</sup>, José Daniel Velásquez<sup>2</sup>, and Manuel Noé Chaur<sup>2,6\*</sup>

<sup>1</sup> Grupo de investigación de fotoquímica y fotobiología, Universidad del Atlántico, Carrera 30 Número 8-49, Puerto Colombia 081008, Colombia; carlosgrande@mail.uniatlantico.edu.co (C.D.G.T.)

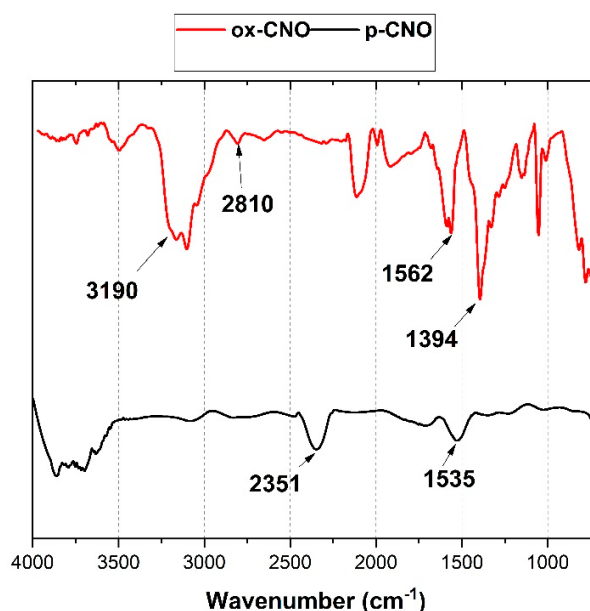
<sup>2</sup> Grupo de Investigación SIMERQO, Departamento de Química, Universidad del Valle, Calle 13 No. 100-00, 76001 Cali, Colombia; jorgecastro@correounivalle.edu.co; manuel.chaur@correounivalle.edu.co (M.N.C.) (J.I.C.); jose.velasquez.carmona@correounivalle.edu.co (J.D.V.)

<sup>3</sup> Escuela de Odontología, Grupo biomateriales dentales, Universidad del Valle, Calle 13 No. 100-00, 76001 Cali, Colombia; carlos.humberto.valencia@correounivalle.edu.co (C.H.V.)

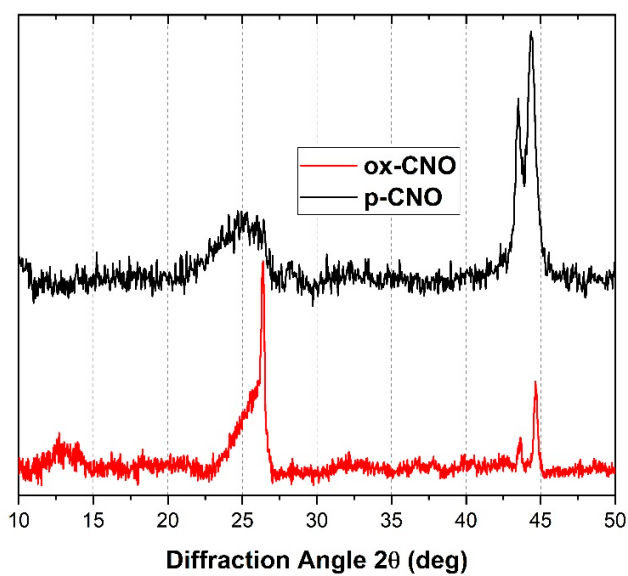
<sup>4</sup> Grupo de Investigación Biotecnología, Facultad de Ingeniería, Universidad de San Buenaventura Cali, Carrera 122 # 6-65, 76001 Cali, Colombia; dnavia@usbcali.edu.co (D.P.N.P.)

<sup>5</sup> Escuela de Ingeniería de Materiales, Facultad de Ingeniería, Universidad del Valle, Calle 13 No. 100-00, Santiago de Cali 760032, Colombia; valencia.mayra@correounivalle.edu.co (M.E.V.); jose.mina@correounivalle.edu.co (J.H.M.)

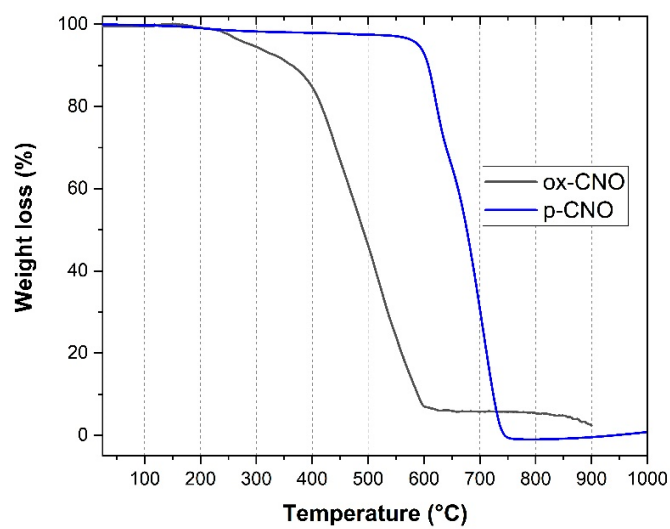
<sup>6</sup> Materiales (CENM), Universidad del Valle, Calle 13 No. 100-00, Santiago de Cali 760032, Colombia; manuel.chaur@correounivalle.edu.co (M.N.C.)



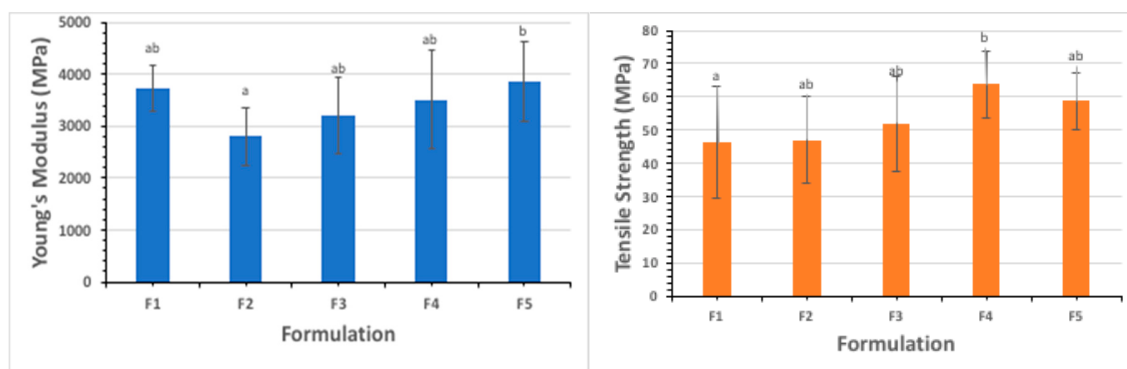
**Figure S1.** Fourier transform infrared spectroscopy (FTIR) of p-CNO (black line) and ox-CNO (red line).



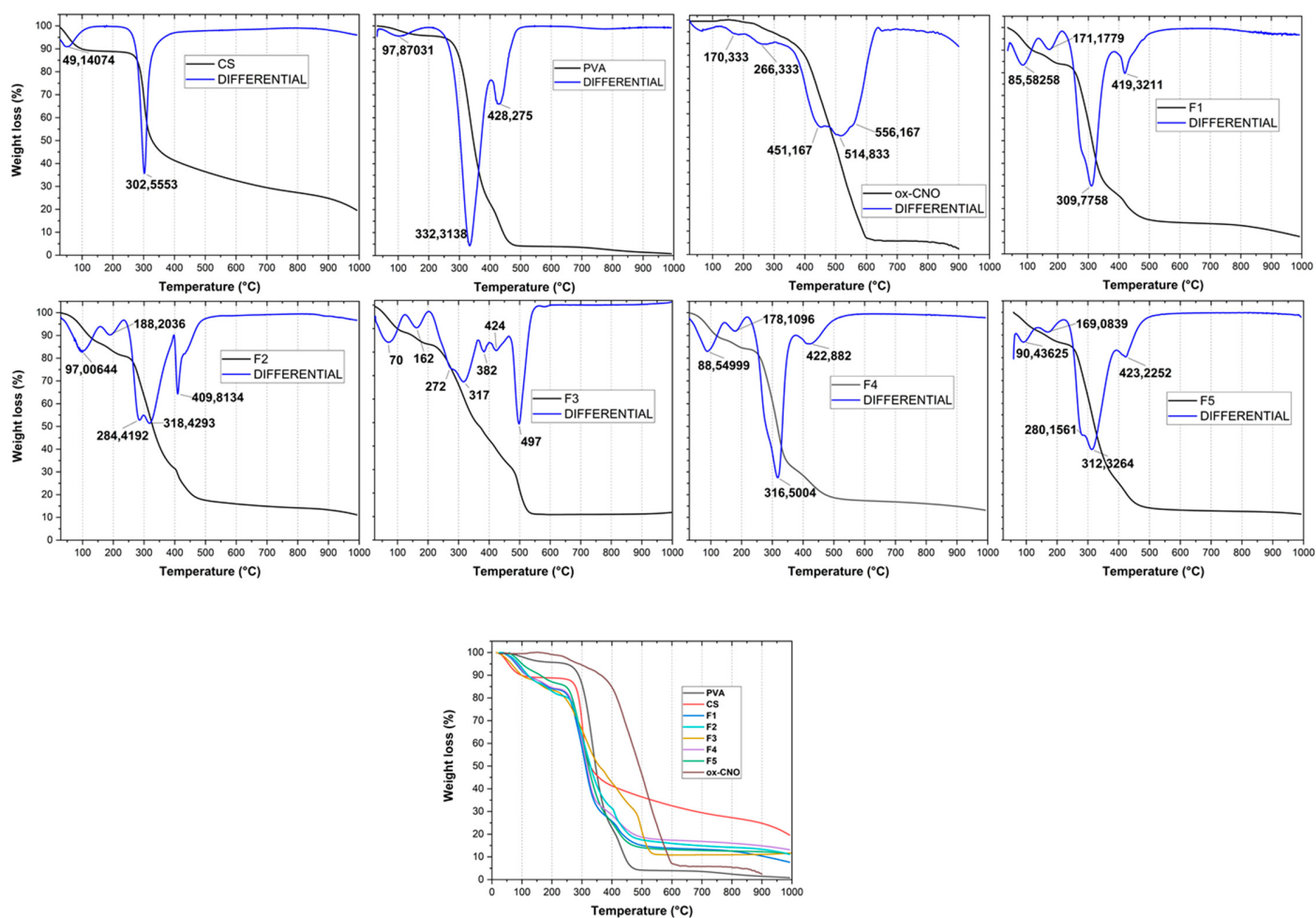
**Figure S2.** X-ray diffraction (DRX) of p-CNO (black line) and OX-CNO (red line).



**Figure S3.** TGA of the oxidized carbon nano-onions and pristine carbon nano-onions.



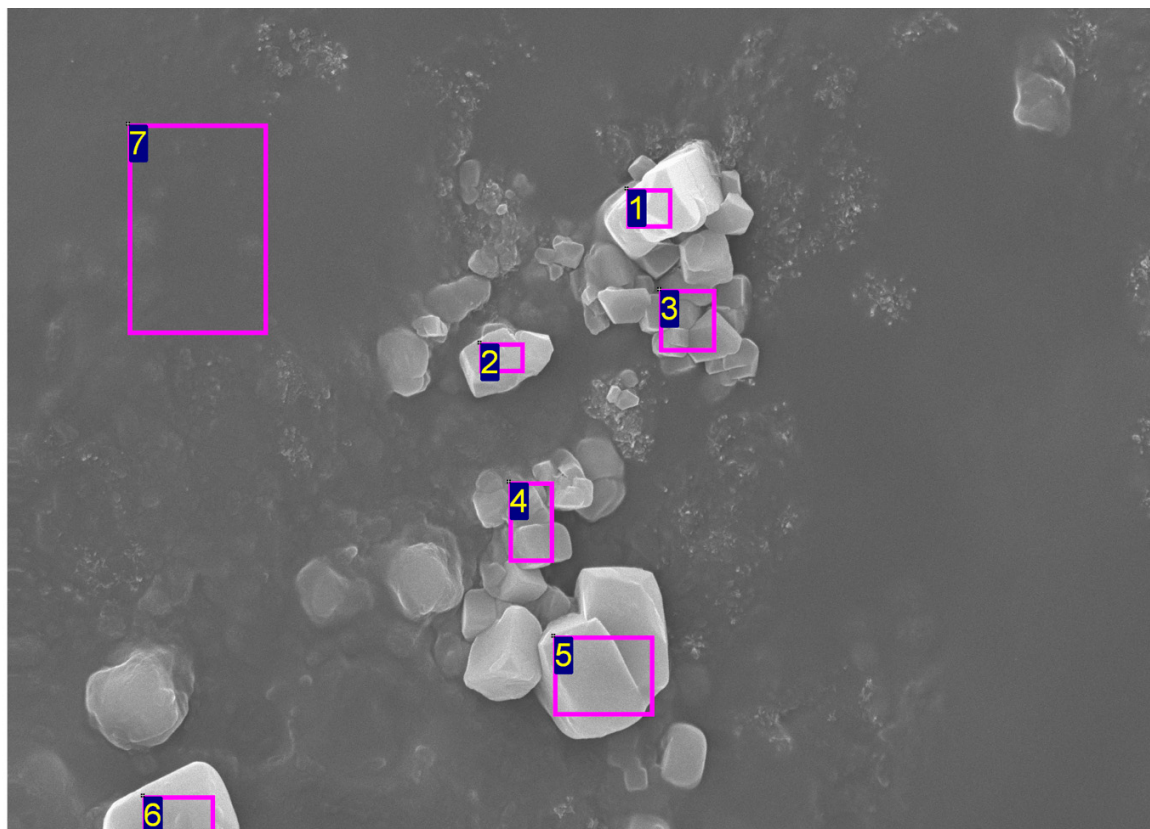
**Figure S4.** The Young's modulus (left) and tensile strength (right) of CS/PVA/ox-CNO films. Formulations: F1 (CS:PVA:ox-CNO 30:70:0); F2 (CS:PVA:ox-CNO 29.75:70:0.25); F3 (CS:PVA:OX-CNO 29.50:70:0.50); F4 (CS:PVA:ox-CNO 29.25:70:0.75); F5 (CS:PVA:ox-CNO 29.00:70:1.00). Different superscript letters indicate significant differences between treatments ( $p > 0.05$ ).



**Figure S5.** TGA curves of the films. Formulations: F1 (CS:PVA:ox-CNO 30:70:0); F2 (CS:PVA:ox-CNO 29.75:70:0.25); F3 (CS:PVA:ox-CNO 29.50:70:0.50); F4 (CS:PVA:ox-CNO 29.25:70:0.75); F5 (CS:PVA:ox-CNO 29.00:70:1.00)

- EDS images for all the formulations (F1-F5)

F1

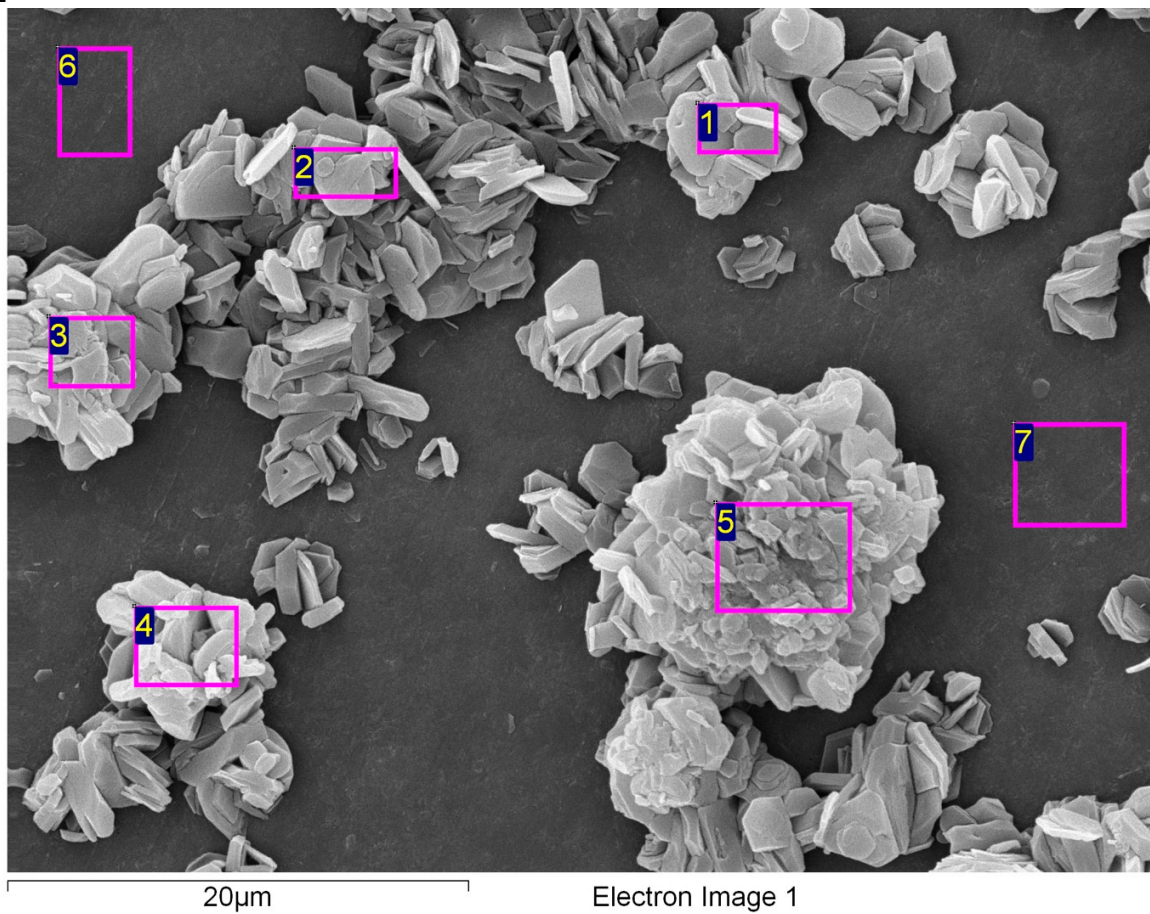


Processing option : All elements analysed (Normalised)

| Spectrum   | In stats. | B     | C     | O     | Cl    | K     | Ca   | Total  |
|------------|-----------|-------|-------|-------|-------|-------|------|--------|
| Spectrum 1 | Yes       |       | 35.26 |       | 31.22 | 33.52 |      | 100.00 |
| Spectrum 2 | Yes       |       | 35.95 |       | 30.89 | 33.16 |      | 100.00 |
| Spectrum 3 | Yes       |       | 17.02 |       | 39.78 | 43.20 |      | 100.00 |
| Spectrum 4 | Yes       |       |       | 13.46 | 41.82 | 44.72 |      | 100.00 |
| Spectrum 5 | Yes       | 59.74 | 5.28  |       | 17.50 | 17.48 |      | 100.00 |
| Spectrum 6 | Yes       |       | 25.64 |       | 35.81 | 38.55 |      | 100.00 |
| Spectrum 7 | Yes       |       | 43.73 | 29.22 | 16.68 | 4.85  | 5.52 | 100.00 |
| Max.       |           | 59.74 | 43.73 | 29.22 | 41.82 | 44.72 | 5.52 |        |
| Min.       |           | 59.74 | 5.28  | 13.46 | 16.68 | 4.85  | 5.52 |        |

All results in weight%

F2

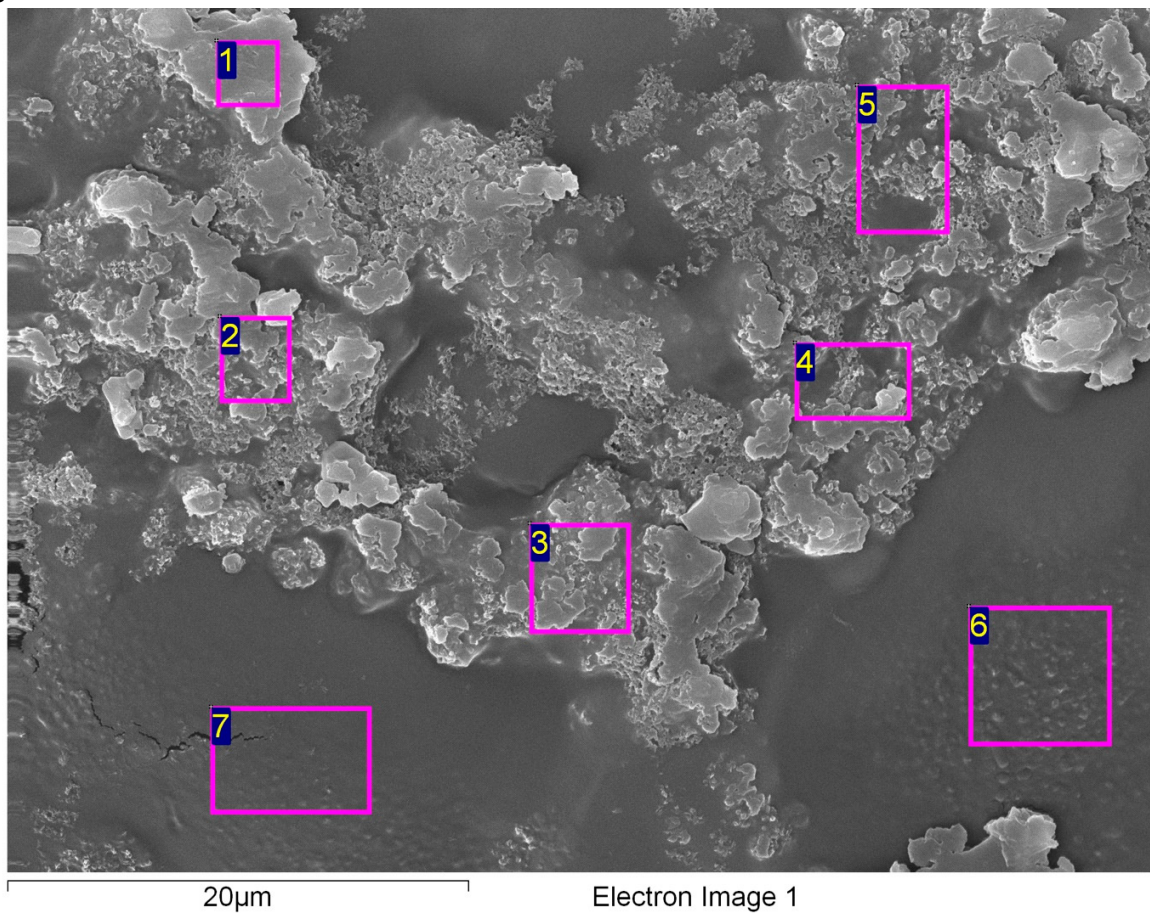


Processing option : All elements analysed (Normalised)

| Spectrum   | In stats. | C     | N     | O     | Na   | P    | Cl    | K    | Ca    | Total  |
|------------|-----------|-------|-------|-------|------|------|-------|------|-------|--------|
| Spectrum 1 | Yes       | 44.90 |       | 34.09 |      |      | 17.38 |      | 3.63  | 100.00 |
| Spectrum 2 | Yes       | 44.82 |       | 33.83 |      |      | 19.07 |      | 2.27  | 100.00 |
| Spectrum 3 | Yes       |       |       | 56.40 |      |      | 39.43 |      | 4.17  | 100.00 |
| Spectrum 4 | Yes       |       | 21.50 | 50.66 | 2.09 |      | 21.47 |      | 4.28  | 100.00 |
| Spectrum 5 | Yes       |       |       | 50.24 |      |      | 49.76 |      |       | 100.00 |
| Spectrum 6 | Yes       |       |       | 53.81 |      |      | 35.65 |      | 10.54 | 100.00 |
| Spectrum 7 | Yes       | 30.37 |       | 32.30 | 3.35 | 1.21 | 16.12 | 2.34 | 14.31 | 100.00 |
| Max.       |           | 44.90 | 21.50 | 56.40 | 3.35 | 1.21 | 49.76 | 2.34 | 14.31 |        |
| Min.       |           | 30.37 | 21.50 | 32.30 | 2.09 | 1.21 | 16.12 | 2.34 | 2.27  |        |

All results in weight%

F3

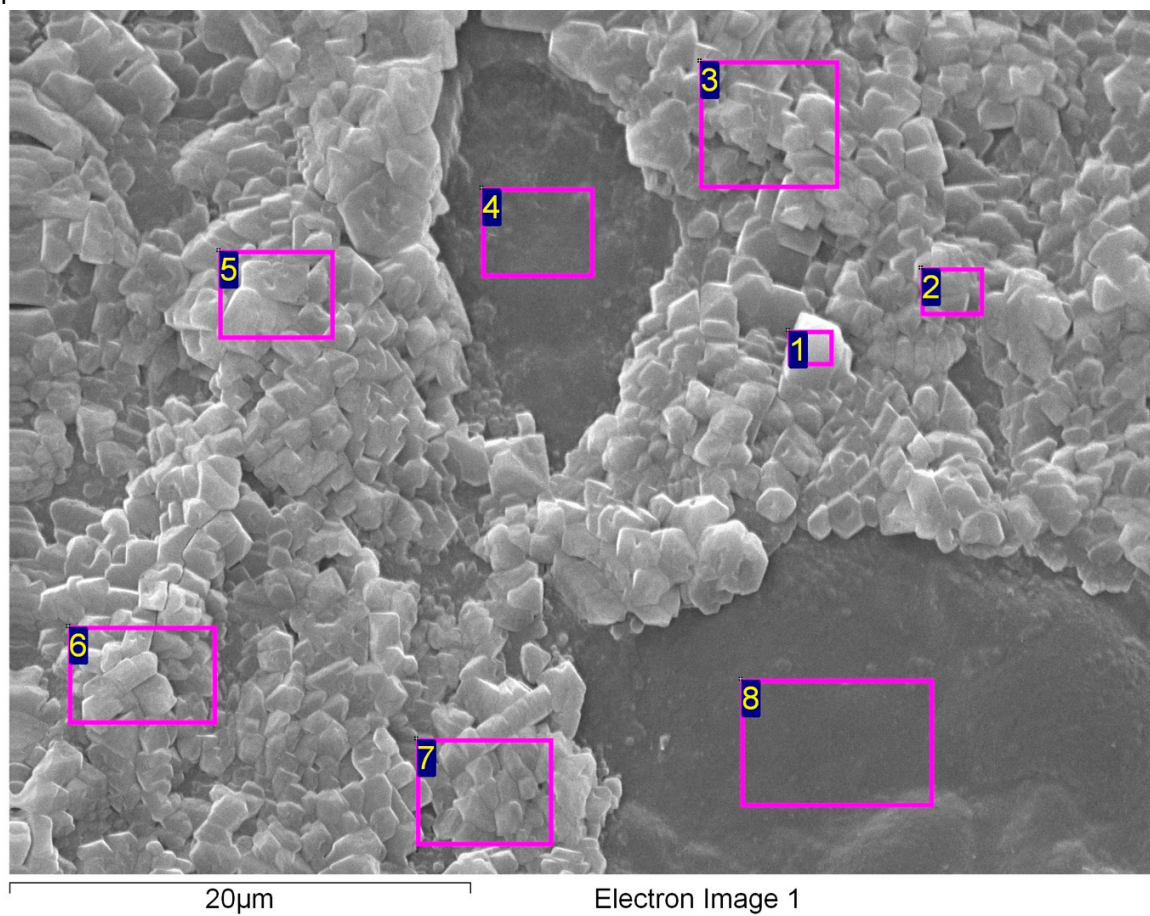


Processing option : All elements analysed (Normalised)

| Spectrum   | In stats. | C     | O     | Na   | P     | Cl    | K     | Ca    | Total  |
|------------|-----------|-------|-------|------|-------|-------|-------|-------|--------|
| Spectrum 1 | Yes       |       | 41.36 | 4.24 |       | 25.35 | 16.31 | 12.74 | 100.00 |
| Spectrum 2 | Yes       |       | 33.27 | 3.40 | -0.51 | 29.27 | 23.66 | 10.91 | 100.00 |
| Spectrum 3 | Yes       |       | 32.39 | 2.33 | 1.91  | 28.70 | 25.84 | 8.84  | 100.00 |
| Spectrum 4 | Yes       |       | 47.17 | 2.73 | 0.92  | 23.03 | 15.14 | 11.01 | 100.00 |
| Spectrum 5 | Yes       | 41.77 | 32.91 | 1.78 | 1.34  | 9.86  | 4.15  | 8.18  | 100.00 |
| Spectrum 6 | Yes       | 41.60 | 39.13 |      |       | 12.11 | 1.79  | 5.37  | 100.00 |
| Spectrum 7 | Yes       | 46.46 | 34.53 |      |       | 13.61 |       | 5.41  | 100.00 |
| Max.       |           | 46.46 | 47.17 | 4.24 | 1.91  | 29.27 | 25.84 | 12.74 |        |
| Min.       |           | 41.60 | 32.39 | 1.78 | -0.51 | 9.86  | 1.79  | 5.37  |        |

All results in weight%

F4

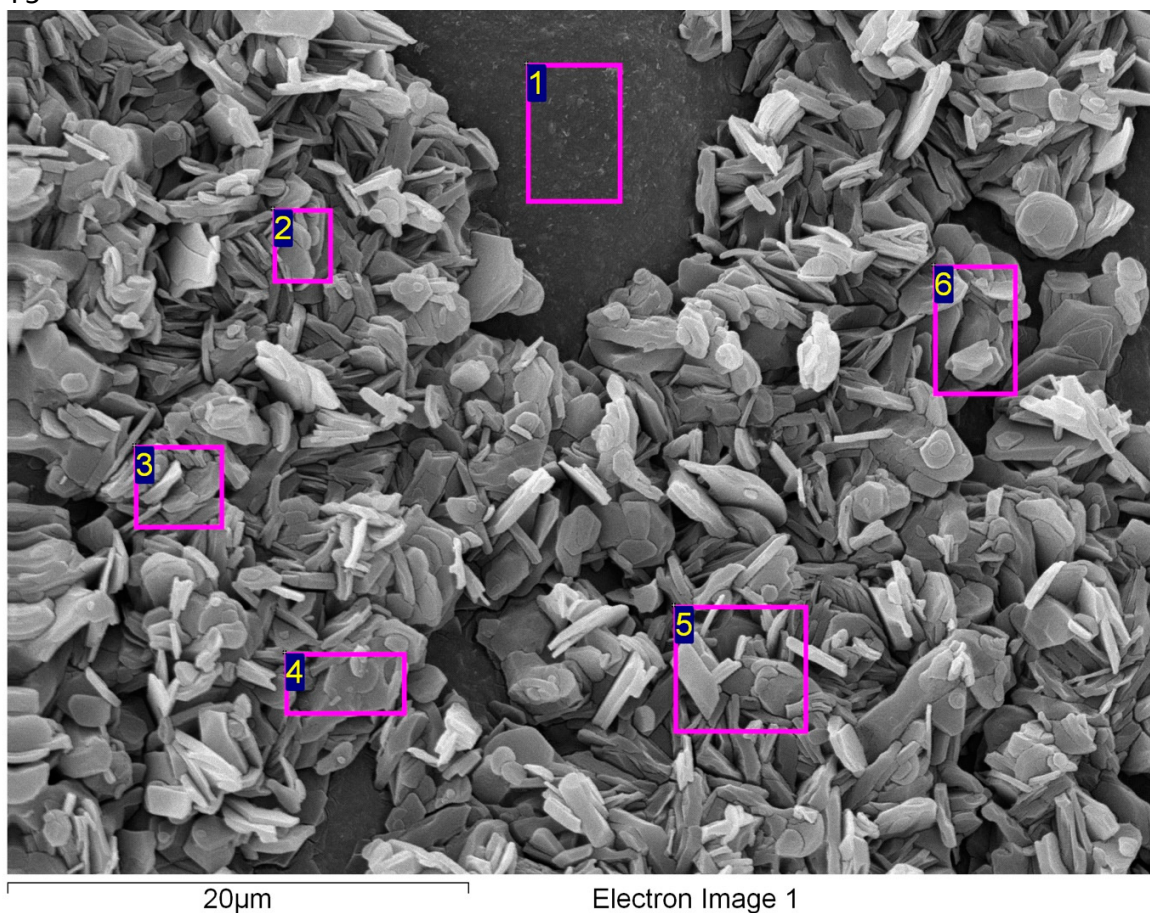


Processing option : All elements analysed (Normalised)

| Spectrum   | In stats. | C     | O     | Na    | Cl    | Ca   | Total  |
|------------|-----------|-------|-------|-------|-------|------|--------|
| Spectrum 1 | Yes       | 31.70 |       | 27.72 | 40.59 |      | 100.00 |
| Spectrum 2 | Yes       |       |       | 34.53 | 65.47 |      | 100.00 |
| Spectrum 3 | Yes       |       |       | 35.29 | 64.71 |      | 100.00 |
| Spectrum 4 | Yes       |       | 17.25 | 27.02 | 54.31 | 1.43 | 100.00 |
| Spectrum 5 | Yes       |       |       | 37.44 | 62.56 |      | 100.00 |
| Spectrum 6 | Yes       |       |       | 35.88 | 64.12 |      | 100.00 |
| Spectrum 7 | Yes       | 26.39 |       | 26.68 | 46.93 |      | 100.00 |
| Spectrum 8 | Yes       |       | 19.11 | 24.79 | 56.10 |      | 100.00 |
| Max.       |           | 31.70 | 19.11 | 37.44 | 65.47 | 1.43 |        |
| Min.       |           | 26.39 | 17.25 | 24.79 | 40.59 | 1.43 |        |

All results in weight%

F5



Processing option : All elements analysed (Normalised)

| Spectrum   | In stats. | C     | O     | Cl    | Ca   | Total  |
|------------|-----------|-------|-------|-------|------|--------|
| Spectrum 1 | Yes       | 41.65 | 39.52 | 13.75 | 5.08 | 100.00 |
| Spectrum 2 | Yes       |       | 48.63 | 51.37 |      | 100.00 |
| Spectrum 3 | Yes       |       | 53.92 | 46.08 |      | 100.00 |
| Spectrum 4 | Yes       |       | 49.56 | 47.06 | 3.38 | 100.00 |
| Spectrum 5 | Yes       |       | 53.65 | 44.09 | 2.27 | 100.00 |
| Spectrum 6 | Yes       |       | 55.22 | 39.68 | 5.11 | 100.00 |
| Max.       |           | 41.65 | 55.22 | 51.37 | 5.11 |        |
| Min.       |           | 41.65 | 39.52 | 13.75 | 2.27 |        |

All results in weight%

**Image S1.** Energy-dispersive X-ray spectroscopy (EDS) results of the formulations F1-F5.