EPDIC16

16th European Powder Diffraction Conference

1 - 4 July 2018

John McIntyre Conference Centre

University of Edinburgh, Edinburgh, UK

http://epdic16.efconference.co.uk/

THE UNIVERSITY OF EDINBURGH

Green chemistry and nanotechnology for a sustainable agriculture

G. Dal Sasso[a,b*], F.J. Carmona Fernàndez[b,c], G.B. Ramìrez Rodrìguez[b,c], J.M. Delgado Lopez[d], F. Ferri[b,c], D. Redoglio[b,c], F. Bertolotti[b,e], J.S. Pedersen[f], N. Masciocchi[b,c], A. Guagliardi[a,b]
[a]*Istituto di Cristallografia, Consiglio Nazionale delle Ricerche, Como, Italy.*
[b]*Total Scattering Laboratory (To. Sca. Lab.), Como, Italy.*
[c]*Dipartimento di Scienza e Alta Tecnologia, Università dell'Insubria, Italy.*
[d]*Department of Inorganic Chemistry, Faculty of Science. University of Granada, Spain.*
[e]*Aarhus Institute of Advanced Studies (AIAS), Aarhus University, Denmark.*
[f]*Department of Chemistry, INANO, Aarhus University, Denmark.*
**gregorio.dalsasso@ic.cnr.it*

In the last decades, the massive application of conventional fertilizers, constituted by highly soluble N- and P-rich compounds, caused severe environmental pollution in terms of eutrophication of water bodies. In fact, most of the macronutrients are leached away by rainwater, highlighting the low efficiency of these fertilizers and the wasteful exploitation of non-renewable sources, such as phosphate ores. On a future perspective, considering the unceasing world population growth and the subsequent increase of food demand, increasing the crop yields by intensifying the use of conventional fertilizers is environmental unsustainable. On these bases, this research aims to integrate nanotechnology into the development of more efficient and sustainable fertilizer [1]. Carbonated-calcium phosphate nanoparticles – amorphous and hydroxyapatite-based nanocomposites - are synthetized by chemical precipitation [2] and designed to incorporate N-based macronutrients. Here, we show the results of nanoparticles characterization through synchrotron-based Wide Angle X-ray Total Scattering (WAXTS), Small Angle X-ray Scattering (SAXS) and Static and Dynamic Light Scattering (SLS/DLS) techniques. Advanced modelling techniques based on the Debye scattering equation [3] are applied to diffraction data to extract information on crystallinity degree, crystal structure, size, morphology and composition of nanoapatites obtained at different maturation time and doping. Additional information on the size and shape of nanoparticles is also provided by SAXS analysis. The structural and microstructural information coupled with measurements of stability and nutrients release enables us to control the macronutrients release over time due to the progressive dissolution of nanoparticles by modulating their size, structure and composition. Initial tests on grapevines and wheat plants make these materials highly promising smart fertilizer for future exploitation.

[1] Liu R., Lal R., 2015. The science of the total environment, 514, 131-139.
[2] Delgado-Lõpez J.M., Frison R., Cervellino A., Gõmez-Morales J., Guagliardi A., Masciocchi N., 2014. Advanced Functional Materials, 24 (8), 1090-1099.
[3] Cervellino A., Frison R., Bertolotti F., Guagliardi A., 2015. Journal of Applied Crystallography, 48, 2026-2032.

Acknowledgments: This work has been supported by Fondazione Cariplo, Project n. 2016-0648: Romancing the stone: size-controlled HydroxyaPATItes for sustainable Agriculture (HYPATIA)

Keywords: nano-hydroxyapatite, sustainable agriculture, X-ray total scattering