Effect of organic matter on size and structural strain of nano-ZnS formed in organic waste

M. LE BARS[1,2], C. LEVARD[2], S. LEGROS[3], G. DUBLET[4], A. FERNANDEZ-MARTINEZ[5], D.BORSCHNECK[2], J. ROSE[2], E. DOELSCH[1]

[1]CIRAD, UPR Recyclage et risque, Montpellier, France
[2]Aix Marseille Université, CNRS, IRD, INRA, College De France, CEREGE, Aix en Provence, France
[3]CIRAD, UPR Recyclage et risque, Dakar, Senegal
[4]Environmental Microbiology Laboratory, EPFL, Lausanne, Switzerland
[5]Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, 38000 Grenoble, France

Anaerobic digestion (AD) provides an interesting method for the treatment of organic wastes (OW) that results in biogas production and in the agricultural valorisation of the digestate as fertiliser. OW often contain large amounts of zinc (Zn), potentially toxic for soil living organisms on the long term. Therefore, the effect of AD on Zn speciation in OW needs to be understood in order to determine the risks associated with digestate recycling. ZnS have already been evidenced in digestates in varying proportions according to past studies [1-2]. Besides, the dissolution in soil is faster for ZnS precipitated in OW than for ZnS from other origins [3-4].

In order to better understand the influence of the treatment on Zn speciation, a systematic study was developed. OW were sampled from nine AD and composting plants that cover most of the current recycling practices. Zn K-edge Extended X-ray Absorption Fine Structure (EXAFS) was used to determine Zn speciation. We showed that nano-ZnS is the dominant Zn phase in all digestates. The high reactivity of those nano-ZnS is reflected by the drastic change of Zn speciation along the OW treatment chain. The OW is a too complex matrix to investigate these processes. Therefore to go further into the mechanisms that drive ZnS reactivity, laboratory batch experiments were used. Nano-ZnS of different sizes were synthetized in presence of organic molecules in the laboratory and characterized by X-ray Diffraction (XRD) and Wide Angle X-ray Scattering (WAXS). Pair Distribution Function (PDF) analyses were perfomed from WAXS patterns. Structural size-dependent properties were manifested and the influence of OM on both size and strain was demonstrated.

[1] Lombi et al. (2012) *ES&T*, *46*, (16), 9089-9096.
[2] Legros et al. (2017) *ES&T*, *51*, (18), 10326-10334.
[3] Formentini et al. (2017) *Env. Pol., 222*, 495-503.
[4] Voegelin et al. (2011) *ES&T*, *45*, (1), 255-261.