Iron effect on the oxidation, colour and antibacterial activity of zinc nanostructures for active food packaging produced by magnetron sputtering

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Zinc oxide nanoparticles are known as an antibacterial agent with a great variety of applications in the industrial field, especially in food packaging. Recently, it has been demonstrated that the mixed oxides from Zn (Zinc) and Fe (Iron) can be used as a pigment and humidity sensor **[1-3]**. Based on these applications, Zn and Zn-Fe nanostructures were produced to evaluate their colour and antibacterial properties during their oxidation when exposed to different ranges of humidity. Particular emphasis is placed on highlighting the effect of the Fe content on the functional properties.

Zn and Zn-Fe nanostructures were produced using two different methodologies, (i) a classical magnetron sputtering, and a hybrid system composed by a cluster gun and a magnetron sputtering. All depositions were performed in Ar atmosphere, varying the current density, from 0.1 to 0.5 A, and deposition time. The morphology and elemental analysis were evaluated by scanning (transmission) electron microscopy (SEM and STEM), energy dispersive spectroscopy (EDS) and Inductively Coupled Plasma (ICP). Colour measurements were carried out in a CM-2600d/MINOLTA spectrometer and the antibacterial tests were assessed by the zone of inhibition (ZOI) assay.

The samples were classified by thickness, Zn-Fe concentration/fraction, and morphology (NPs/film). Afterwards, the results demonstrated, a significant effect of the insertion of Fe in Zn nanostructures. Consequently, an increase of the fraction of Fe caused a lower L* value and a decrease of the antibacterial activity when compared to pure Zn nanostructures.

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