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STRUCTURAL CHARACTERIZATION OF BIOLOGICAL SELENIUM NANOPARTICLES BY X-RAY ABSORPTION SPECTROSCOPY AND ELECTRON MICROSCOPY

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A wide diversity of microorganisms has been recognized to enzymatically reduce toxic selenium forms (SeVI and SeIV) to non-toxic elemental selenium (Se0). The Se0 formed is usually produced in form of nanoparticles (NPs) with a wide array of shapes (spheres, nanorods, nanowires, etc.) structures (amorphous, monoclinic, trigonal, etc.), and sizes, which influence their environmental behaviour and industrial applications. The local chemical structure of these NPs of interest can be characterized by synchrotron-based analytical techniques such as X-Ray absorption spectroscopy (XAS) and electron microscopy. In the present study, selenium NPs synthesized by the cells of the bacterium Stenotrophomonas bentonitica after exposure with SeVI and SeIV were analysed with these techniques. The near-edge structure (XANES) region of the Se reduction products showed that the local coordination of Se is dominated by Se0 for both initial sources of Se. The extended fine structure (EXAFS) spectra indicated the presence of one Se-Se coordination shell at a bond distance of about 2.33–2.34 ± 0.02 Å and 2.35-2.37 ± 0.003-0.004 Å for SeIV and SeVI as initial source, respectively. According to the literature, the bond distance around 2.33-2.34 correspond to amorphous Se (a-Se), while the bond distances of 2.35-2.37 Å could correspond to a mixture of a-Se and trigonal Se (t-Se). Further characterization of the selenium NPs with electron microscopy coupled to electron diffraction (ED) and Fast Fourier Transform (FFT) showed a crystallization process of a-Se nanospheres to t-Se crystalline nanostructures. The results presented herein showed the potential of S. bentonitica for bioremediation purposes and a green and cheap methodology to produce selenium NPs of substantial interest for industrial and medical applications.

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