Saudi Journal of Biological Sciences (2017) 24, 1–10

King Saud University

Saudi Journal of Biological Sciences

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REVIEW

Possible domestication of uranium oxides using biological assistance reduction

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Received 19 May 2015; revised 3 September 2015; accepted 6 September 2015
Available online 14 September 2015

KEYWORDS

Uranium;
Nanoparticles;
Bio-respiration intervention;
Bio-reduction;
Structural characterization

Abstract Uranium has been defined in material research engineering field as one of the most energetic radioactive elements in the entire Mendeleev periodic table. The manipulation of uranium needs higher theories and sophisticated apparatus even in nuclear energy extraction or in many other chemical applications. Above the nuclear exploitation level, the chemical conventional approaches used, require a higher temperature and pressure to control the destination of ionic form. However, it has been discovered later that at biological scale, the manipulation of this actinide is possible under friendly conditions. The review summarizes the relevant properties of uranium element and a brief characterization of nanoparticles, based on some structural techniques. These techniques reveal the common link between chemical approaches and biological assistance in nanoparticles. Also, those biological entities have been able to get it after reduction. Uranium is known for its ability to destroy ductile materials. So, if biological cell can really reduce uranium, then how does it work?

Contents

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.sjbs.2015.09.010

1. Introduction

The synthesis of organic and inorganic materials has been related to the mastery of matter and fire (Livage, 1977). Humanity had discovered the natural fire in earliest times after the Stone Age, and since late of the Glass Age (2500 years BC), human beings have been coining the idea to manipulate the natural fire in primitive ways. During Bronze Age (2200–750 years BC) and Iron Age (750–50 years BC) metals were melted. Controlling the temperature was a serious issue, while purifying some metals. The temperature here was less than 3000 °C (Rees, 1993). Fire was used to sculpt and modify the texture and smoothness of the surface. It was not until the late ages that humanity was able to use chemical fire with more mastery over fire. This was made possible by controlling more matter twice using temperature and by the introduction of equation methods (Crosland et al., 1959). Many hybrids and composites between some specific metals became possible. One step needed more than 10,000 °C, the "chemists" could then design the materials at this level with large possibility of combinations. It has only been no more than 150 years that nuclear fire was discovered. This type of energy needed a strong theory, materials and methods to manipulate the energy at this scale. Then it has also opened the possibility of creating new isotopes, which has never existed before in the nature. Amidst all this dynamic discovery of manipulation of the matter– with use of more pressure and temperature, to shift and control various energy levels, in the living world– the entities have a strong ability to calmly manipulate different levels of energy to control and master the materials in peaceful ways. Using methods which work under physiological conditions and creating a veritable art, from difficult reactions the veritable art becomes the inspiration to sculpt and develop materials (Nassif and Livage, 2011). Many reactions were possible within micro-organisms at low temperature and pressure, however with conventional chemistry methods it needed several conditions. It was eventually concluded that inside the physiological conditions there was other chemistry that had been taking place much earlier than the beginning of the life on this planet. Green chemistry has become a technical word, referring to the low temperature and low pressure conditions of reactions, generally inspired from the methodology prevailing at that natural and/or biological scale.

Many elements are manipulated by microorganisms for their energy needs and it consists of shifting the ionic valence to create balance in global charge and the correction of the concentration distribution between different compartments of the cell to create a dynamic equilibrium responsible for the life of the cell. Many other elements are present in the environment but they are lethal for the cell which can end the living entity even in low concentration. As they have other non desirable properties, however the same consequence can be obtained with higher concentration of the main elements. Especially metallic atoms are so highly active in terms of oxido-reduction, the studies were concerned with the effects of concentrations of many metals on the biology of cells (Nies, 1999). Microorganisms developed in a preexisting system, from the capacity to manipulate exogenous amount of metals to be protected from the ionic forms. Ions are competitive and with various affinities can interfere with the vital metabolism of the cell and create dangerous situations. For that it is wise to shift this form to less competitive and if possible the new form can be used for other new ability. For instance, as regards the bacteria discovered by Blackmore in 1975 in some place with higher concentration of iron, the bacteria synthesize iron nanoparticles to minimize the internal amount of ionic form and synthesize the iron nanoparticles with a simple methodology, that can distribute it in the cell edifices before assisting it to be orientated in magnetic field in which it lives (Blakemore, 1975). Other elements like gold,

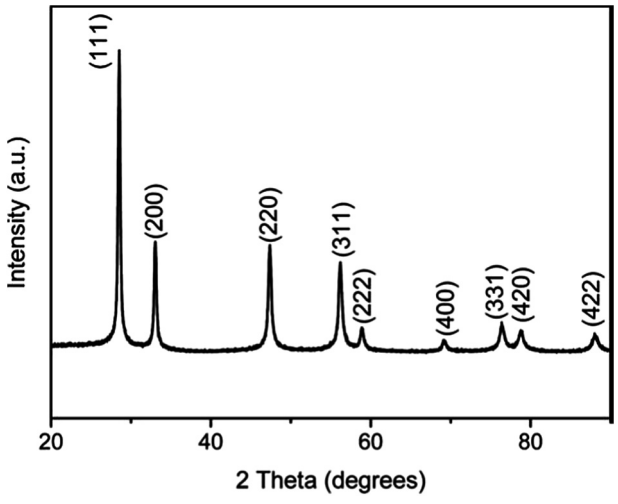

Figure 1 XRD pattern prototype of UO_2NPs (from Wang et al., 2008).