Study of the behavior of clay materials under irradiation

Understanding the phenomena of irradiation in clay materials is particularly important in the context of the deep geological storage of radioactive waste. For instance, it is proposed to use MX-80 bentonite as a component of the engineered barrier. During its use, the clay will undergo changes in its water content. It is therefore necessary, which is currently not the case, to understand how radiation will affect clay minerals and which parameters concern their reactivity under irradiation (amount of water, type of water, nature of the clay mineral).

In these clay minerals, hydrogen has several types of speciations: the OH^- groups linked to cations in octahedra, water molecules at the edge or at the surface of the sheets and interlayer water molecules hydrating the compensating cation. Firstly, it is important to understand whether ionizing radiation affects one water type rather than another. The comparison of several clays containing different types of water should help answer this question. All these studies will be performed at several relative humidities in order to understand the influence of the humidity of the medium on the reactivity under irradiation.

The irradiation of clay minerals revealed electron transfer phenomena from the sheets of the clay to the interlayer space.[1] In the presence of water or hydroxyl groups, these electrons can then lead to the formation of dihydrogen. Measuring the production of dihydrogen is therefore a good probe of the reactivity under ionizing radiation.[2,3] Working with clay minerals having different surface charges on the sheets will then help understand if these charges have an influence on the electron transfer at interfaces.

Thus, to better understand the mechanisms implied under irradiation, the nature of the compensating cation, the nature and the amount of water, the negative charge delocalized over the siloxane surface, will be varied, allowing measuring their impact on the dihydrogen production under irradiation. In parallel, changes in the clay structure and in the amount of water will be characterized by various techniques (EPR, X-ray diffraction, diffuse reflectance spectroscopy, infrared spectroscopy, thermogravimetric analysis). These experiments are possible using synthetic analogues of clay minerals of variable and imposed composition, in order to understand the effects induced by controlled cationic substitutions in the sheets. Synthesis is performed hydrothermally by a sol-gel method, at IMPMC, Institute of Mineralogy and Physics of Condensed Matter from Pierre et Marie Curie University (Jean-Louis Robert).

References

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Contact
Sophie Le Caër
Institut Rayonnement Matière de Saclay
Service Interdisciplinaire sur les Systèmes Moléculaires et les Matériaux
UMR 3299 CNRS/CEA SIS2M
Laboratoire de Radiolyse, Bâtiment 546
F-91191 Gif-sur-Yvette Cedex
France
email: sophie.le-caer@cea.fr
phone: 33 1 69 08 15 58
fax: 33 1 69 08 34 66