Infrared spectroscopy of Uranium Oxides by ATR technology

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1. Introduction

IR spectroscopy is a useful technique for the characterization of chemical species [1,2].

ATR (Attenuated Total Reflection) technology gives direct IR spectrum measurement of all kinds of sample forms like solid, powder and liquid without any conventional pretreatment of the samples. The advantage of direct measurement of ATR could be useful for radioactive samples which are not easy to handle. In this work, IR (Infra Red) spectra measurement of uranium oxides (UO_{2+x}) using ATR was carried out in order to investigate the applicability of this technique for uranium oxide characteriztion.

2. Experimental

2.1. Preparation of UO_{2+x} (x=0 to 2.67)

The samples of UO_{2+x}, where x=0, 0.021, 0.025, 0.054, 0.076, 0.092, 0.110, 0.118, 0.142, 0.187, 0.388, 0.545, 0.604 and 0.67, were prepared by heating UO_2 in air atmosphere at the expected corresponding temperatures for some target values of x for 2 hours and by weighing the gains by oxygen. The corresponding temperatures for the target values of x were chosen from the thermogravimetric curves of the UO_2 oxidation [3].

2.2. Measurement of the IR spectra of UO_{2+x}

The IR spectra for the prepared UO_{2+x} samples were measured in the range 4000 to 400 cm^{-1}.

3. Results and discussion

3.1. Spectra for the UO_{2+x} (x=0 to 0.07)

Fig. 1 shows the spectra for the UO_{2+x}, where x=0 to 0.07, of low x values. There is no specific peak for the UO_2. On the other hand some variation near 500cm^{-1} is shown, that is, the spectra become inflated with increasing x. As shown in Fig. 2, the height of spectra is growing near 638cm^{-1} with increasing x.

3.2. Spectra for the UO_{2+x} (x=0.12 to 0.67)

Fig. 3 shows the spectra for the UO_{2+x}, where x=0.12 to 0.67, of higher x values. Specific peaks are shown in the range 715 to 728 cm^{-1}, where the peaks are shifted to lower wave number range and grow with increasing x. Other specific peaks of 800 cm^{-1} at the shoulder of foregoing peaks are shown and also grow with increasing x. Another shoulder peak of 636 cm^{-1} is clearly shown except the spectra of x=0.67 which should be of U_3O_8.

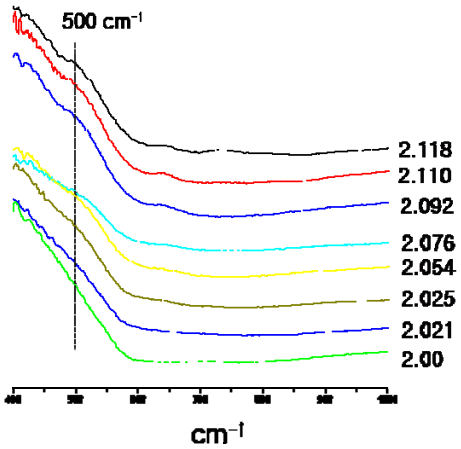

Fig. 1. IR spectra for the UO_{2+x} of low x values.

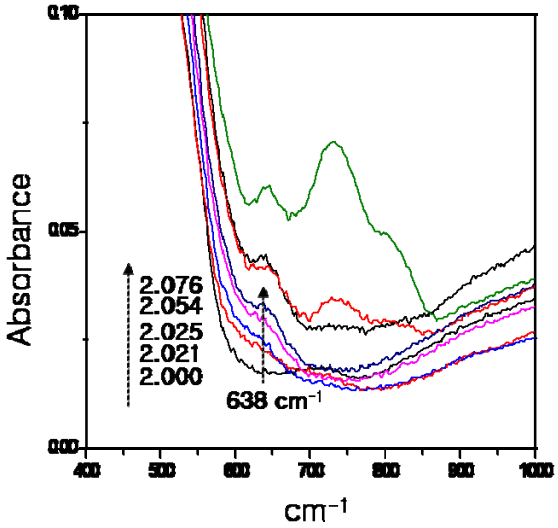

Fig. 2. IR spectra showing the height increase at 638 $cm^{-1}$with increasing x.

3.3. Quantitative relationship between peak heights and x.

In order to know whether there is some quantitative relationship between peak height and x, the absorbance values at a specific wavenumber are plotted against 2+x.

Fig. 4 is the plot of the absorbance against 2+x from Fig. 2, where the selected wavenumber is 638cm^{-1}.

Fig. 5 is the plot of the absorbance against 2+x from Fig. 3, where the wavenumbers giving highest levels are selected in the range 715 to 728 cm^{-1}.

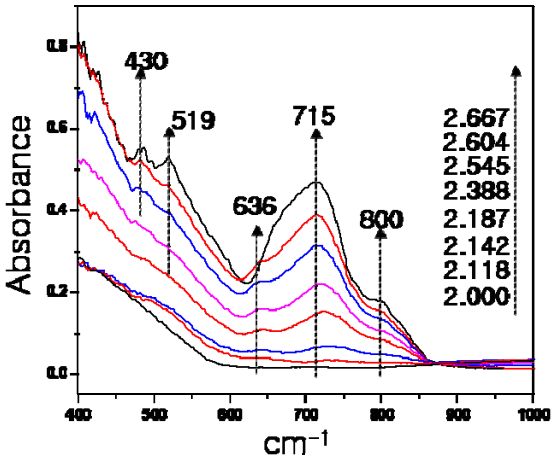

Fig. 3. IR spectra for the UO_{2+x} of higher x values.

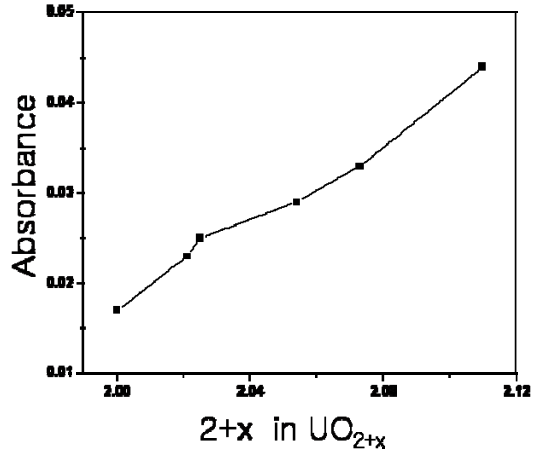

Fig. 4. The plot of the absorbance at 638 cm^{-1} against 2+x from the spectra of Fig. 2.

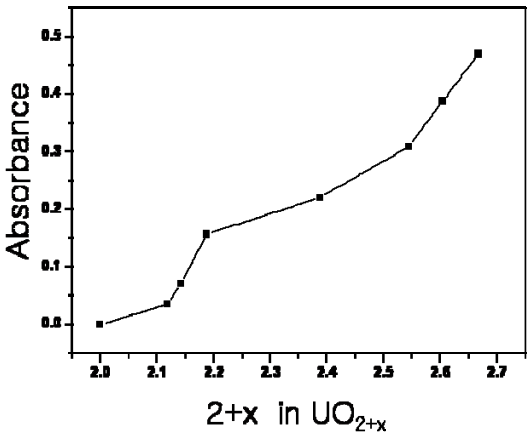

Fig. 5. The plot of the absorbance (near 715 cm^{-1}) against 2+x from the spectra of Fig. 3.

4. Conclusion

IR (Infra Red) spectra of uranium oxides (UO_{2+x}) where x=0 to 0.67 were measured using ATR-FTIR. The applicability of ATR-FTIR for the characterization of uranium oxide materials and as an useful method of O/U ratio estimation were confirmed.

REFERENCES

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