

**SPATIAL LOCALITY IN INVESTIGATION OF THE TECHNETIUM  
ELECTRON STRUCTURE IN COMPOUNDS BY CONVERSION ELECTRON  
SPECTROSCOPY**

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In present work the spatial locality is considered as the important property influencing on interpretation of experimental results. The conversion electron spectroscopy data obtained for the technetium compounds is analysed. The examples for another spectroscopic methods are used in a discussion of the characteristics, capabilities, and probable range of applications of conversion electron spectroscopy (CES).

The basic equipments were the HP 5950 A double-focusing electrostatic X-ray spectrometer made by “Hewlett-Packard” and analogous RPS-2 spectrometer made in Russia. The energy resolution of instruments was equal to about 1 eV. The residual-gas pressure in the working chamber of spectrometers was  $\sim 2 \times 10^{-9}$  Torr. The X-ray photoelectron spectroscopy method was used for monitoring of the chemical state of experimental samples.

The principal feature of conversion electron spectroscopy [1] is the localization of the conversion process in the small vicinity around the nucleus [2, 3]. First for the E3 transition of  $^{99m}\text{Tc}$  used in the CES investigations of the technetium electron structure, the region of an occurrence of the conversion process was estimated in 1951 [4]. It was found that the conversion probability is determined by the region close to the technetium nucleus with a radius of around 0.2 Å. Later, for the E3 transitions of  $^{99m}\text{Tc}$  and  $^{235m}\text{U}$ , more accurate estimates were obtained [3, 5]. An accuracy of 1% is attained in the region close to the nucleus with radius  $< 0.05$  Å in both cases. Therefore the greater part of the interatomic space does not participate in generation of CES spectra practically. In this case the spatial locality is determined by properties of conversion process. We designate this spatial locality as the spatial locality of first level here.

On the other hand, CES method applies the tagged atom technique for preparation of the samples for investigation as highly radioactive isotopes are used usually. In other words,

CES method utilizes the sensitivity to the chemical state of the specific atoms (tracers). This important circumstance creates conditions for second level of the spatial locality in CES investigations of the compound electron structure. The spatial locality of second level is given by an investigator choice of appropriate experimental technique.

Samples prepared for research is conveniently divided into three types:

- 1) the technetium chemical compounds of the wellknown chemical state and crystalline structure;
- 2) the technetium compounds of the nonstoichiometric composition but of the known quantitative one or compounds containing technetium in two or more chemical states;
- 3) the nonstoichiometric samples containing a very small quantity of technetium and having the partly known composition only.

Samples of first type were used earlier (see [1] and references in them). In this case the spatial locality of first level was used for the investigation of the nature of the chemical bond and for a verification of the various theoretical calculation methods. The participation of the spatial locality of second level is unimportant for samples of first type.

Samples of second and third types are complicated for using by ordinary methods as X-ray photoelectron and X-ray emission spectroscopies because the complexity of spectra. The CES method is more expedient for research on account of the relative simplicity of spectra. The CES spectra contain information only about a chemical state of the tagged atoms of technetium and its nearest atomic environment. The spatial localities of both first and second levels can be used. In compounds containing atoms of technetium in different chemical states, atoms of only one state can be labeled. According to [6, 7], the absolute sensitivity of the CES method for  $^{99m}\text{Tc}$  is  $10^{-11}$  g in investigations with respect to the 3d line of Tc. The absolute sensitivity of the CES method in this case is 3 – 4 orders of magnitude greater than the absolute sensitivity of the X-ray photoelectron spectroscopy. The sensitivity of ordinary methods is often small for the investigating of samples of third type because a high background. Thus an application of the CES method is desirable.

The experimental spectra of samples of first, second and third types were measured. The obtained results were analyzed. The spatial locality taken into account for the CES provides the additional information for investigated samples. The research carried out allows the prospects for the CES method to be evaluated.

The conversion method is promising for investigations of the nature of the chemical bond and the structure of molecular orbitals. The practical application of the CES method is

evidently most valuable for using of surface properties – especially, catalitic and corrosional – and for the investigation of the chemical state of the element whose presence in small concentrations determines the important physicochemical properties of the medium.

### Referencies

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