Appendix 1: BELARUS

Development of barrier composite coating technology for low level radioactive waste disposal

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This work is devoted to research relating to the development of new thin film barrier coatings, the associated preparation technique, and their use for solving various scientific and engineering problems associated with the improvement of the performance of low level waste disposal facilities. The work presents the main results of zirconium dioxide thin film coatings preparation process by organometallic composite solutions on various substrates and bases with subsequent thermal treatment at 400–1000°C.

Experimental work on the formation of isolating corrosion-resistant ZrO_2 (Y_2O_3) coatings over different substrates and bases, including microporous ones, indicate potential applications of the technology to coating barrier materials such as quartz, sand, concrete, alumina.

Two variants of pulse thermal treatment are proposed. The first variant was designed for samples with an irregular surface and having a large surface area. It is suggested that such surfaces are treated using step-by-step heating of local sections.

Experimental

1. Preparation technique

- $ZrCl_4$ alcoholised by ethanol with Zr $(OC_2H_5)_2Cl_2$ formation,
- Zr $(OC_2H_5)_2Cl_2$ dissolving at alcohol,
- dipping into the solution,
- drying in the air,
- thermal treatment in the furnaces for 1–10 seconds or 10–180 minutes at 200–500°C.

2. Deposition technique

Three glass ampoules were taken and 0.5 ml of $^{137}CsNO_3$ aqueous solution (1.6×10^6 Bq) were injected in each ampoule. After drying the ampoules under a lamp, 0.5 ml each of the protective solution were injected into two ampoules, which were dried under the lamp and annealed in a muffle furnace for 3 hours at 50°C. After cooling to room temperature, 0.5 ml of protective solution was injected into one of these ampoules again. The three ampoules were dried and annealed for 3 hours at 200°C. All the three ampoules were placed in beakers with 50 ml of tap water.

3. Measurements

Measurements of ^{137}Cs activity with a multichannel spectrometer gave the values shown in Table A.1, which are very small compared to the activity injected into the specimens.

TABLE A.1. ACTIVITY DYNAMICS OF ^{137}Cs (Bq) IN THE TAP WATER

Object under test	Conditions and time (hour) kept in the tap water					
	17.0		91.25		134.0	
	without ZrO_2	with ZrO_2	Without ZrO_2	with ZrO_2	without ZrO_2	with ZrO_2
Quartz	17600	1030	25200	10700	33600	21100
Sand	2140	338	6900	357	7530	355
Concrete	1120	210	1680	166	1770	234
Aluminium	38200	4220	35200	3510	37900	1980

Conclusions

The following can be concluded from the experimental test data:

— Relationships between the structure, chemical composition, physical and mechanical characteristics of oxide layers and organometallic compositions were established.

— Protective buffer coatings on microporous materials and formation processes were studied.

— The test results showed that zirconium dioxide protective films notably decrease radionuclides (^{137}Cs) penetration out of the samples into the environment. Moreover, the samples with two-layer zirconium dioxide coatings displayed more retention in comparison with one-layer samples.