Molecular Plating of Mixed Alpha Radionuclides for Energy Calibration and Quality Assurance of CDC Alpha Spectrometer Instrument

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An important component of high precision and accuracy for bioassay alpha emitter-based measurements is the use of a suitable alpha spectrometer instrument with a high-performance detector calibrated with an alpha radionuclide mixed standard source. The Centers for Disease Control and Prevention's (CDC) electroplated standards were created by a molecular plating method and have been used to calibrate all detectors of the alpha spectrometer instruments. The optimum plating condition for the deposition of mixed radionuclides on the stainless steel planchets can be achieved at a potential of 800V and current density of 1-5 mA/cm^2 for 15 minutes. The target thickness of 2.5–7.5 ng/cm^2 can be obtained with a good quality and acceptable uniformity that is appropriate for a calibration standard source in an alpha spectrometer instrument.

Based on 128 solid state ORTEC ULTRA-AS BU-020-450-AS detectors, the mean peak channel and peak energy of U-238, U-234, Pu-239 and Am-241 source had low relative standard deviation (RSD) and bias with a good energy resolution. The average energy calibration and detector efficiency determined by CDC electroplated standard sources was comparable to those parameters obtained with the electroplated standards commercial products from Analytic (Eckert Ziegler). By using the CDC electroplated standards and the commercial electroplated standard sources to compare their characteristics, the results showed that the relative standard deviations of the peak channel and the peak energy of sources were in the range of 0.90-1.20% and 0.02–0.07%, respectively. The average energy resolution of each source was in the range of 1.00 - 2.02%.

CDC electroplated standards were prepared to reduce the QC/QA time from 16 hours counting to 2 hours counting in case of a national emergency response to achieve high sample throughput following the CDC guidelines for compliance with the Clinical Laboratory Improvement Amendments 1988 (CLIA).

Table 1. Average Peak Channel and Peak Energy of U-238, U-234, Pu-239 and Am-241 Standard Sources.

SOURCE:	**CDC Electroplated Standard**				**EZAG Electroplated Standard**			
CHANNEL	U-238	U-234	Pu-239	Am-241	U-238	U-234	Pu-239	Am-241
Peak Channel	247 ± 3	368 ± 3	448 ± 4	519 ± 5	246 ± 3	368 ± 4	448 ± 5	518 ± 6
Ideal Peak Channel	245	364	441	509	245	364	441	509
% RSD	1.12%	0.94%	0.98%	0.91%	1.16%	1.01%	1.05%	1.08%
BIAS	0.90%	1.18%	1.63%	1.93%	0.55%	0.98%	1.55%	1.81%
ENERGY	U-238	U-234	Pu-239	Am-241	U-238	U-234	Pu-239	Am-241
Peak Energy (keV)	4198 ± 2	4773 ± 4	5153 ± 3	5489 ± 3	4198 ± 2	4773 ± 3	5154 ± 3	5488 ± 2
Ideal Peak Energy (keV)	4196	4776	5155	5486	4196	4776	5155	5486
% RSD	0.05%	0.07%	0.07%	0.05%	0.04%	0.07%	0.05%	0.04%
BIAS	0.05%	-0.05%	-0.05%	0.05%	0.04%	-0.06%	-0.03%	0.04%
FWHM (keV)	76 + 9	79 + 8	62 + 7	64 + 7	74 ± 5	78 ± 4	60 ± 4	60 ± 4
Energy Resolution (%)	(1.80 ± 0.21)%	(1.65 ± 0.16)%	(1.21 ± 0.14)%	(1.16 ± 0.12)%	(1.77 ± 0.11)%	(1.63 ± 0.08)%	(1.17 ± 0.08)%	(1.09 ± 0.07)%
Detector Efficiency (%)	ε = (20.4 ± 2.31)%				ε = (20.9 ± 097)%			
Energy Calibration Eq. (keV)	E (keV) = 4.7511*Channel + 3023.6 (R^2 = 1)				E (keV) = 4.7573*Channel + 3028.9 (R^2 = 1)			

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