Alpha Measurement and Control from a Supplier Perspective

Presented by
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PURE TECHNOLOGIES

I am Jerry Cohn, co-founder of Pure Technologies, and for almost 20 years now, we have been suppliers of low, ultra-low and super ultra-low alpha materials. I have been asked to present some information regarding alpha measurement and how we obtain consistency of alpha quality from a supplier's perspective.

I will attempt to explain how we control the quality and consistency of our material without sounding like a commercial – a bit difficult to do. Of course I will not divulge proprietary information but will give you some glimpse into what we do to accomplish this.

PRODUCTION

We developed our proprietary process and have continued to improve it over the past 18 years. Like others, we begin with the best raw materials possible. Each metal is separately processed – tin, lead, copper, silver, etc. Chemical and alpha testing begins on each incoming material.

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To minimize radon contamination, air for the entire manufacturing area, and especially in our two laboratories, is taken 25 meters above the ground and filtered prior to entering our facility.

We process each metal to remove unwanted elements and impurities.

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Then from each metal - the removal of radioactive isotopes and more testing.

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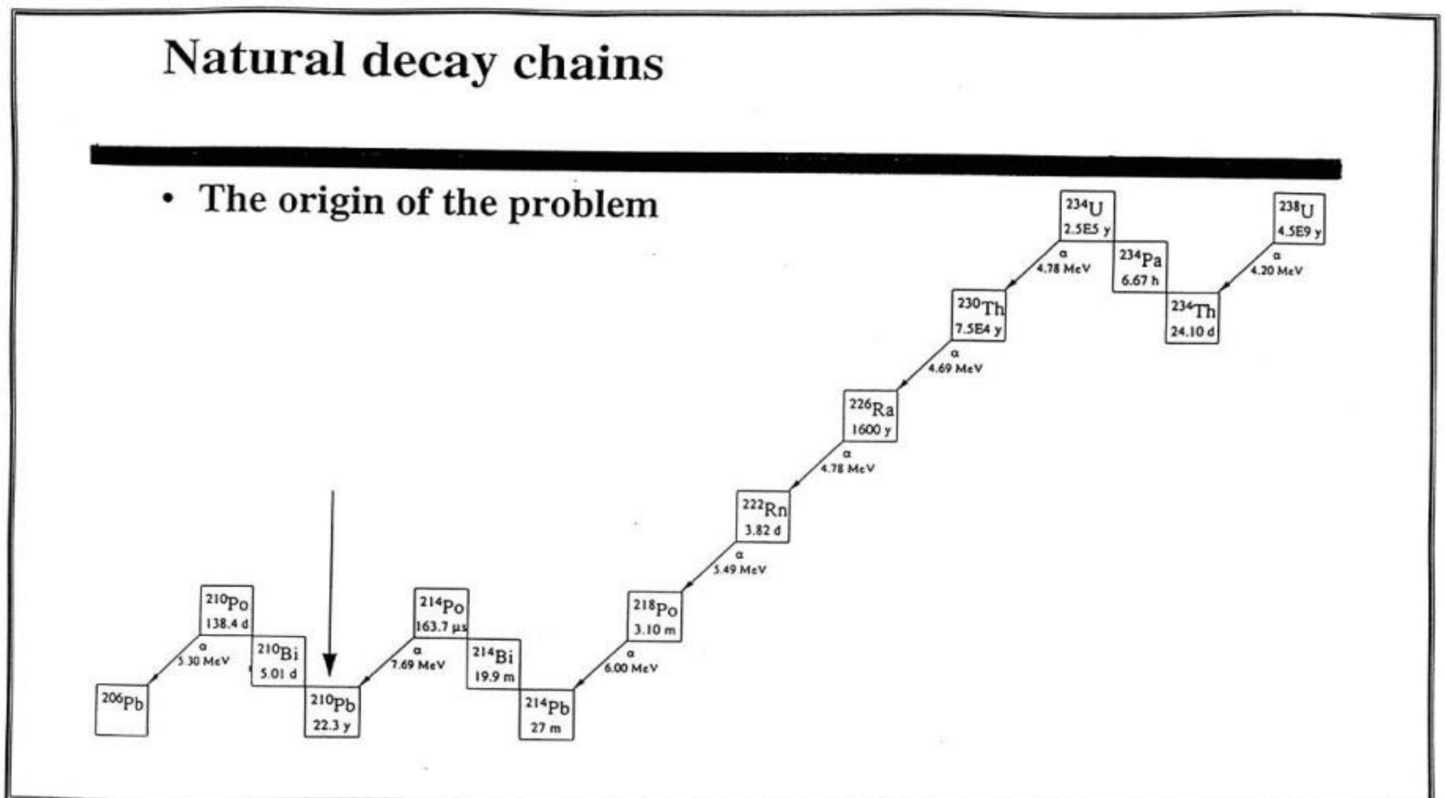
It is necessary to remove radioactive isotopes and especially **Pb^{210}**. Some firms tried removing Po^{210} , an easier process, but the material will not be at secular equilibrium, as Pb^{210} , higher in the decay chain, will continue to decay and emit more Po^{210} , which will result in increasing alpha emissions over time. This method does not result in material that is in secular equilibrium and is not acceptable.

SECULAR EQUILIBRIUM is when the decay of Pb^{210} is equal to or less than the decay of Po^{210}.



Let us talk about ULA TIN (Sn)… Today, the most-used metal is tin (Sn). A common concept is that to obtain ULA tin (<0.001 cph/cm2), it is necessary to remove virtually all Pb in the tin (down to <0.1 ppm) from the tin. We feel that this concept and this tin may not maintain that alpha emission rate over time and could be a problem for customers.

It is well known that lead consists of 4 stable (non-radioactive) isotopes: Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} and one radioactive isotope Pb^{210} (Pb^{210} produces Po^{210} which is a major source of alpha particles).

The problem is that the content of **Pb^{210}** in different batches of tin concentrate can differ by 1000 and more times. We roughly calculated that the content of Pb^{210} must be < 0.00001ppb (not ppm but ppb) in order to get alpha emission rate of 0.001 cph/cm2.

If we were to just reduce the content of lead in tin, even up to 0.01 ppm (i.e. 10 ppb or less) it does not automatically mean that the alpha emission of the tin is < 0.001 cph/cm2 and that it is in secular equilibrium. According to our experience it is more important to remove **Pb^{210}** and other alpha emitting sources. We know how to do this and therefore we produce SULA Tin < 0.001 cph/cm2 with any content of Lead : Sn100 + some % of impurities, alloys Sn90Pb10, Sn10Pb90 and Sn63Pb37, etc.

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After processing, we test and then store each individual metal – tin, lead, copper, silver, etc. These metals are then ready for a customer's order or for alloying and to be put into the required form/shape.

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After the metal has undergone its processing and testing, it is stored for future use. We have found that by producing large batches – 500 kg or larger - results in efficiency in manufacturing and testing, even though more inventory is required.

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This inventory is necessary as it gives us the opportunity to test and retest the material over time so as to certify and guarantee that the material is at secular equilibrium and will not increase in alpha emissions. Consistency.

Alpha test results over time

Material	Date of production	Dates of alpha test	Alpha emission, cph/cm2	Alpha Specification
Sn (99.999) Lot 18D	30.03.2004	20.05.2004 05.02.2007 10.08.2009 09.06.2011 23.05.2013	0.00056±0.0004 0.00030±0.0002 0.00065±0.0003 0.00080±0.00045 0.00070±0.00036	0.001 cph/cm2
63Sn/37Pb Lot 12C	05.01.2001	10.01.2001 15.01.2003 12.02.2005 06.03.2008 20.04.2013	0.0012±0.00033 0.0009±0.0003 0.0011±0.0004 0.0012±0.0005 0.0011±0.0004	0.002 cph/cm2
96.5Sn/3.0Ag/0.5Cu Lot 204C	25.04.2007	01.05.2007 06.04.2008 17.06.2010 25.05.2012	0.0011±0.0003 0.0010±0.0002 0.0010±0.0004 0.0011±0.0005	0.001 cph/cm2

Upon receiving a customer’s specific order, the metal or metals required for an alloy are combined into a homogeneous batch. After alloying, this batch is again tested.

An archival sample of each batch is stored for future reference.

The tested material or alloy is then put into the required form or shape and then retested.

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MEASUREMENT OF IMPURITIES AND ALPHA EMISSIONS

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We use a calibrated ICP device for analysis of chemical elements. If a customer wants further analysis a sample can be sent to an independent laboratory for GDMS or other testing.

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Sometimes a customer requires their own testing of a sample from their order prior to shipping, which is fine with us. We send a sample to them for their verification.

Alpha Measurement

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For the alpha measuring lab, in addition to taking air high above the ground and filtering it, we keep a positive pressure in this room to minimize any contamination.

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Taking **sufficient time** to accurately measure the alpha emissions is very important.

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In order to obtain accurate alpha emission measurements, we have found it necessary to take enough time to measure the background ***before*** and ***after*** measuring the sample. We average the background rate in determining the sample’s alpha emission rate.

Back-ground (counts/ Hr)	Area (cm^2)	Alpha flux 0.001 $\alpha/cm^2 \cdot Hr$		Alpha flux 0.002 $\alpha/cm^2 \cdot Hr$		Alpha flux 0.003 $\alpha/cm^2 \cdot Hr$	
		t_b Hr	t_t Hr	t_b Hr	t_t Hr	t_b Hr	t_t Hr
3	1000	145	164	39	48	18	25
	900	178	200	47	58	22	29
	500	563	601	145	164	67	79
4	1000	191	210	50	60	23	30
	900	235	256	61	72	29	36
	500	745	783	191	210	87	100
5	1000	236	255	62	71	28	35
	900	291	312	75	86	35	42
	500	926	964	236	255	107	120

Back-ground (counts/ Hr)	Area (cm^2)	Alpha flux 0.004 $\alpha/cm^2 \cdot Hr$		Alpha flux 0.005 $\alpha/cm^2 \cdot Hr$		Alpha flux 0.01 $\alpha/cm^2 \cdot Hr$	
		t_b Hr	t_t Hr	t_b Hr	t_t Hr	t_b Hr	t_t Hr
3	1000	11	16	7	11	2	4
	900	13	18	9	13	3	5
	500	39	48	26	33	7	11
4	1000	14	19	9	13	3	5
	900	17	22	11	15	4	6
	500	50	60	33	41	9	13
5	1000	17	21	11	15	3	5
	900	20	26	15	18	4	6
	500	62	71	40	48	11	15

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Peculiarities Of Measuring The Alpha Particle Activity Of Flat Samples Of Metals, Alloys And Powders Using Gas Flow Proportional Counters Specifically the Model 1950 Manufactured by "Spectrum Sciences", USA

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ABSTRACT

Naturally occurring radioactive emissions from solder (Pb/Sn or Pb-free) in semiconductor devices may result in memory device malfunctions and possible consequential product liability. These "soft errors" occur randomly but do not cause permanent physical damage to the memory cell. The principal product developed to reduce the probability of soft error malfunctions in memory devices is low alpha lead/tin alloys and low alpha lead-free alloys.

Copies of this paper are available on our website:

www.puretechnologies.com.

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That concludes my presentation. I shall try and answer any questions you may have.

Questions can be sent to me at:

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