# Low-Level Measurement of Alpha-Particle Emitters in Ceramics and Metals

*A.R. Smith, R.J. McDonald, D.L. Hurley, and E.B. Norman*

Nearly all natural materials contain trace quantities, typically in the PPM range, of U and Th. Even processed materials often contain these elements in the PPB range. These radioactive elements decay via complex alpha and beta decay chains, forming 11-15 daughter nuclides each, many of which emit alpha particles in their own decay. When close enough to sensitive electronic components, such as transistors in an IC chip, they can disrupt the normal operation of prcessors or memory.

Direct alpha counting techniques using solid state or gas-filled detectors can be used to measure activity, but this method is only sensitive to a 0.01-0.03 mm surface layer and, unless even much thinner films are used, provides only a count rate and not spectrographic information. Besides examining only a small part of the material, alpha detecection rates are low and can be distorted by contamination, i.e. from radon in the air.

For the assay of U and Th in materials, at the PPB level, low-background gamma-ray spectroscopy is a very sensitive and isotope-specific method for determining the bulk concentrations of these radionuclides in essentially all solid and liquid materials, including ceramics, metals, plastics, and etchants. While some of the U- and Th-series alpha-emitters are not detected directly, the gamma-ray evidence correctly indicates the present levels of alpha-activity, and also provides accurate predictions for how the alpha-activity may change with time. 5 kg samples provide adequate counting rates at the PPB level for 1 day counting times.

For the analysis of $^{210}$Pb in Pb, thinner samples are required to measure the characteristic 46 keV gamma ray, but counting rates are similar to those for alpha counters, spectrographic information is obtained, and no wait is needed for the ingrowth of $^{210}$Po.

The low-background facity is presently seeking an industrial partner to work on these problems. The 115% n-type detector at the LBF underground Oroville site has the sensitivity to measure 10 Bq/kg levels in 100 g samples of Pb and 1 PPB levels of U and Th in 5 kg samples of metals or ceramics.