There are three sources of moisture, and potentially condensate or adsorbate, in hermetic packaged micro-electronic devices.

One possible source is the atmosphere in which packages are sealed. Water vapor as an impurity in the source blanket gas, or which entrains through leaks in lines delivering that gas to the sealing equipment, will become entrapped in the enclosure. Gas supplies and delivery piping are generally well controlled, so this factor seldom causes elevated internal moisture in packages.

Another source of internal moisture is the package materials themselves. Moisture can stick to package piece part walls and other materials, only to outgas post-seal to be present in headspace. Adhesives, conformal coatings, and other polymeric materials used in package assembly are a major source of volatilized water if not fully cured and desiccated prior to package sealing.

Another significant source of package moisture is failure of the hermetic enclosure. Leak paths can be present, or open up after seal, in the seal material periphery or at pin feedthroughs, admitting external ambient water vapor through the leak path. The rate at which moisture actually enters an enclosure headspace is a complicated function of leak path geometry, physics and chemistry of leak path surfaces, temperature and temperature cycling, external humidity, and other factors.

Moisture in hermetic packages has always been a concern of the microelectronics industry. In the 1970s, moisture in semiconductor packages caused a major retrofit of missile electronic systems onboard nuclear submarines. In the 1980s, moisture inside an IC in an onboard computer caused a launch abort of a space shuttle. In the 2000s, moisture ingress into implanted medical devices caused patient harm and extensive litigation. Among other failure modes, moisture corrodes metals, causes electrical instability, promotes stiction in the moving parts of MEMs, and fogs optical surfaces.

With the development of mass spectrometry as a means of measuring moisture in hermetic enclosures in the 1970s (Mil.Std 883J, Test Method 1018.6), a JEDEC working group settled on 5000 parts per million by volume (0.5 volume percent) as a limit for moisture in sealed devices. Three premises guided selection of this limit:

a) It was felt by analysts working in the field that it was a concentration measurable with reasonable accuracy by mass spectrometry systems of the time,

b) 5000 ppmv corresponded to a dewpoint temperature of -2°C (just below freezing), and

c) 5000 ppmv was the threshold concentration for adsorbing three monolayers of water molecules on surfaces, the layer thickness that in turn is the threshold for surface electrical conduction that promotes instability or galvanic effects in devices.

Moisture control depends on three things:

a) Materials and processes that produce a dry package headspace at time of seal,

b) Materials and processes that ensure no volatility of moisture from materials within the headspace during packaged device storage and service life, and

c) Sealing processes that produce truly hermetic seals with minimal or undetectable rates of leakage that will maintain moisture control throughout product service lifetime.

For further information please contact:

info@microcircuitlabs.com
610-228-0161