

SEMI C52-0301

SPECIFICATION FOR THE SHELF LIFE OF A SPECIALTY GAS

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1 Purpose

1.1 The purpose of this document is to define terminology and to recommend minimum periods for the shelf lives of specialty gases. It is meant to provide consistency in terminology among gas suppliers and to provide a general guideline for users of these gases.

2 Scope

2.1 This document applies to the shelf life of properly packaged, filled and analyzed specialty gases as stored or supplied by a specialty gas manufacturer or supplier. In this document, shelf life is viewed from a quality point of view. The document does not address safety aspects associated with the prolonged storage of gases.

2.2 This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Referenced Standards

None.

4 Terminology

4.1 *container* — a lecture bottle, cylinder, cylinder pack, drum or any other vessel which is used to supply a specialty gas.

4.2 *residual level* — The amount of product, as a fraction of the fill weight or fill pressure, which should be left in a container in order to minimize the impact on manufacturing processes of the higher level of impurities in the last gas fraction from a container.

4.3 *shelf life* — the period of time for which the specification of a gas is guaranteed by the supplier, starting from the time of analysis. It defines the period for which the supplier guarantees the actual level of impurities, as analyzed, to remain at or below the specification limit for a particular gas grade.

5 Requirements

5.1 *Factors Affecting the Shelf Life of a Specialty Gas* — Shelf life is a function of the following factors:

a. Thermal stability of the gas

b. Quality of the container and valve

- material selection
- leak tightness

c. Time-dependent reactions between

- gas and impurities
- gas and packaging materials

d. Filling and analytical operations

e. Transport and storage conditions

f. Amount of product in the container

5.1.1 The integrity of the valve is a key factor determining the shelf life of a gas, in particular for low vapor pressure gases. Time dependent reactions can be significantly reduced by purification of the gas to a level where impurities no longer have a significant effect over time, and by selection of proper packaging materials. Chemical and physical treatment of the internal container surface and/or passivation of this surface before filling also reduces the effect of time-dependent reactions. For material and gas compatibility information, please refer to the individual SEMI gas standards.

5.2 *Classification of Specialty Gases on the Basis of Shelf Life* — While there are a large number of specialty gases used in semiconductor manufacturing, for the purpose of defining shelf lives, they can be divided into four groups. It should be noted that for example chemically reactive gases are sometimes classified as non-reactive in the table below as the classification is done from a shelf-life point of view only.

5.2.1 *Non-reactive* — Under normal storage conditions, these gases do not react with ambient air, the packaging materials or the impurities commonly found in the specialty gas.

5.2.2 *Reactive* — These gases react either with ambient air or standard packaging materials.

5.2.3 *Corrosive* — These gases react with packaging materials usually in the presence of traces of moisture.

5.2.4 *Unstable* — These gases are thermally unstable and spontaneously decompose over time.

Table 1 Classification of Specialty Gases on the Basis of Shelf Life

Non-reactive	Reactive	Corrosive	Unstable
Air	AsH ₃	BCl ₃	B ₂ H ₆
Ar	CO	BF ₃	NO
CFH ₃	D ₂	¹¹ BF ₃	
CF ₂ H ₂	GeH ₄	ClF ₃	
CF ₃ H	H ₂	Cl ₂	
CF ₄	NF ₃	F ₂	
CH ₄	PH ₃	GeF ₄	
CO ₂	SeH ₂	HBr	
C ₂ F ₆	SiH ₄	HCl	
C ₃ F ₈	Si ₂ H ₆	HF	
C ₄ F ₈		NH ₃	
C ₅ F ₈		PF ₅	
He		SiCl ₂ H ₂	
Kr		SiCl ₃ H	
Ne		SiCl ₄	
N ₂		SiF ₄	
N ₂ O		WF ₆	
O ₂			
SF ₆			
Xe			

5.3 *Guaranteed Shelf Life Period* — The following guaranteed shelf life periods are recommended as a minimum.

Table 2 Guaranteed Shelf Life Period

Non-reactive	Reactive	Corrosive	Unstable
36 months	24 months	18 months	6 months

5.3.1 When proper packaging materials are chosen and the container is properly prepared (and passivated), impurity levels should in theory remain constant over time for an electronics grade specialty gas with the exception of the thermally unstable gases. For this reason, no maximum shelf life periods are recommended as these will depend on the level of analytical data collected by the manufacturer or supplier.

5.4 *Mixtures* — The shelf life of a mixture is recommended to be equal to the shelf life of the component in the mixture with the lowest shelf life. For example, the minimum shelf life of a reactive gas in a non-reactive gas matrix would be 24 months. The shelf life of a mixture should apply both to the impurity specifications and to the assay of the mixture.

5.4.1 Special attention should be paid to the preparation of the package for mixtures containing less than 1,000 ppm of a component. At such levels, adsorption effects may reduce the shelf life and minimization of the package internal surface roughness and/or passivation of the surface may be required.

5.5 *Residual Level* — The impact of the depletion of a container on impurity levels is still a matter of debate among gas suppliers. In general, the impurity levels of the first gas fraction from a container will differ from the last gas fraction. In particular moisture levels tend to rise at lower gas pressures as a result of the relative increase in importance of the internal container wall and its adsorbed moisture. In addition, in liquefied gases the co-existence of both a gas phase and a liquid phase can have a measurable effect on the distribution of impurities over the gas fractions. It is argued that at the point of liquid-dry some impurities, which prefer solution in the liquid phase over the gas phase, may see a dramatic rise. It is therefore recommended to always leave an amount of product in the container and to avoid a situation of “liquid dry” (i.e., when all of the liquid phase of a liquefied gas has been used).

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