

Contents

1	Introduction: Whiskers and Their Role in Component Reliability	1
1.1	What Are Whiskers?	1
1.2	History of Whiskering	1
1.3	Impact of the Lead-Free Movement	4
1.4	Reported Sn Whisker Failures	4
1.5	Literature Survey of Factors Influencing Whisker Growth	5
1.6	Challenging Aspects of Whisker Studies	14
1.7	Unique Features of the Investigative Plan	20
1.7.1	Film/Substrate Effects	20
1.7.2	Environmental Effects	21
	References	21
2	Film/Substrate Effects on Whisker Growth	25
2.1	The Influence of Film Thickness on Sn Whiskering	25
2.1.1	Ultra-Thin Film Whiskering	27
2.1.2	Thicker Sn Film Whiskering	30
2.2	Whisker Growth from Patterned Arrays of Deposited Sn	34
2.3	A Spectacular Case: Whisker Growth from Sn on Ag Substrates	38
2.4	Sn/Substrate Combinations Which Eliminate the Influence of Intermetallic Formation	41
2.5	Whisker Growth Under Different Film Stress Conditions	53
2.6	Whiskering from Sn Alloy Films	59
	References	65
3	Environmental Effects on Whisker Growth	67
3.1	Effects of Oxygen Exposure on Sn Whiskering	67
3.2	The Influence of Relative Humidity on Whiskering	73
3.3	The Role of Sn Oxide Formation on Whisker Growth	78
3.3.1	Wet Oxidation @ 120 °C	83
3.3.2	Dry Oxidation	83
3.3.3	Bulk, Polycrystalline Sn Dry Oxidation	87

3.4	Is a Surface Sn Oxide Necessary for Whisker Growth?	89
3.5	The Effect of Electrical Bias on Sn Whiskering	93
	References	103
4	Whisker Mitigation and Prevention	107
4.1	Efficacy of POSS Conformal Coating to Block Whiskers.	107
4.2	Suppression of Sn Whiskering Using a Ni Under Layer.	109
4.3	Effectiveness of Hard Metal Cap Layers in Blocking Sn Whiskers	114
	References	122
5	Conclusions	125
5.1	Summary of Results.	125
5.2	Continuing Studies.	129
	References	131
	Curriculum Vitae	133

<http://www.springer.com/978-3-319-00469-3>

Factors Governing Tin Whisker Growth

Crandall, E.R.

2013, XII, 136 p. 92 illus., 65 illus. in color., Hardcover

ISBN: 978-3-319-00469-3