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Designation: F3166 – 16

Standard Specification for High-Purity Titanium Sputtering Target Used for Through-Silicon Vias (TSV) Metallization[1]

This standard is issued under the fixed designation F3166; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification details the generic criteria requirements of high pure titanium sputtering targets used as thin film material for through-silicon vias (TSV) metallization in advance packaging.

1.2 Sputtering target purity, grain size, inner quality, bonding, dimension, and appearance specifications are included in this specification along with references for qualification test methods. Reliability, certification, traceability, and packaging requirements are also included.

1.2.1 *Purity Requirements:*

1.2.1.1 Metallic element impurities, and

1.2.1.2 Non-metallic element impurities.

1.2.2 *Grain **S**ize **R**equirements*—Grain size.

1.2.3 *Inner **Q**uality **R**equirements*—Internal defect.

1.2.4 *Bonding **R**equirements:*

1.2.4.1 Backing plate, and

1.2.4.2 Bonding ratio.

1.2.5 *Configuration Requirements:*

1.2.5.1 Dimension,

1.2.5.2 Tolerance, and

1.2.5.3 Surface roughness.

1.2.6 *Appearance Requirements*—Surface cleanness.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

E112 Test Methods for Determining Average Grain Size

E1001 Practice for Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves

F1512 Practice for Ultrasonic C-Scan Bond Evaluation of Sputtering Target-Backing Plate Assemblies

F1709 Specification for High Purity Titanium Sputtering Targets for Electronic Thin Film Applications

F1710 Test Method for Trace Metallic Impurities in Electronic Grade Titanium by High Mass-Resolution Glow Discharge Mass Spectrometer

2.2 *ASME Standard:*

Y14.5M Dimensioning and Tolerancing[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *backing plate, n*—plate used to support the sputtering material used in deposition processes.

3.1.1.1 *Discussion*—Assembling with the sputtering material by various bonding methods.

3.1.2 *sputtering target, n*—source material during sputter deposition processes; typically, a piece of material inside the vacuum chamber that is exposed to bombarding ions, knocking source atoms loose and onto samples.

3.1.2.1 *Discussion*—The sputtering target product can be classified as monolithic or assembly type according to the configurations as shown in Fig. 1.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

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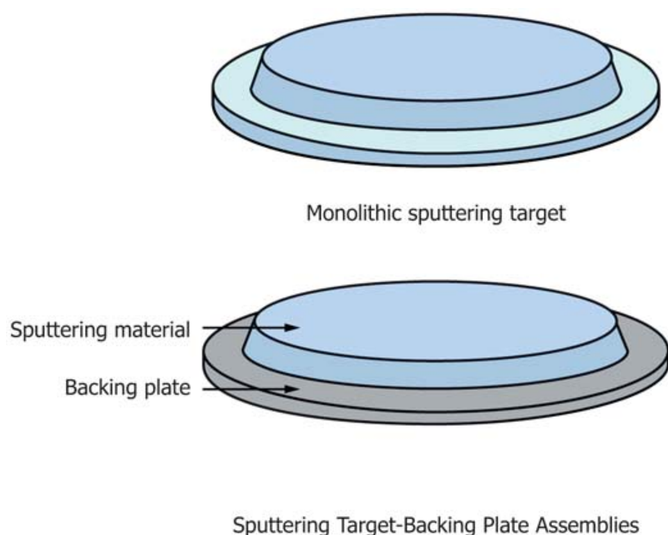

FIG. 1 Sputtering Target Configuration

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *finished product, n—for the purposes of this standard*, a manufactured sputtering target ready for use.

3.2.2 *material lot, n—for the purposes of this standard*, material melted into one ingot and processed as one continuous batch in subsequent thermal-mechanical treatments.

4. Ordering Information

4.1 Advance packaging manufacturers may use this specification to specify required target performance to the supplier when purchasing sputtering target. Target suppliers may also use this specification to specify material requirements to raw material suppliers.

4.2 Orders for pure titanium sputtering targets shall include the following:

4.2.1 Grade and special requirements concerning impurities, if required (Section 5),

4.2.2 Grain size, if required (Section 6),

4.2.3 Inner quality, if required (Section 7),

4.2.4 Bonding ratio, if required (Section 8),

4.2.5 Dimensions, Tolerance and Surface Roughness (Section 9),

4.2.6 Certification required (Section 14), and

4.2.7 Whether or not a sample representative of the finished product is required to be provided by the supplier to the purchaser.

5. Purity Requirement

5.1 *Metallic Element Impurities:*

5.1.1 Grades of titanium sputtering targets for through-silicon vias (TSV) metallization are defined in Table 1 based on typical metallic impurity content of the elements listed in the table. Impurity contents are reported in parts per million by weight (wt ppm). Additional elements may be analyzed and reported as agreed upon between the purchaser and the supplier.

5.1.2 Acceptable analysis methods and detection limits are specified in Specification F1709. Use Test Method F1709 to analyze the purity of titanium by high-mass resolution glow discharge mass spectrometer (GDMS).

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TABLE 1 Suggested Titanium Sputtering Target Grades and Impurity Content Requirements

NOTE 1—Ti purity is 100 % subtract the sum of impurities contents listed in this table.

Element	Units	Test Method	Ti Purity, %	
			99.995 % (4N5)	99.999 % (5N)
Ag	ppmw	GDMS	≤0.2	≤0.2
Al	ppmw	GDMS	≤5.0	≤2.0
B	ppmw	GDMS	≤0.1	≤0.1
Ca	ppmw	GDMS	—	≤1.0
Co	ppmw	GDMS	≤1.0	≤0.1
Cr	ppmw	GDMS	≤5.0	≤1.0
Cu	ppmw	GDMS	≤2.0	≤1.0
Fe	ppmw	GDMS	≤15.0	≤7.0
K	ppmw	GDMS	≤0.1	≤0.1
Li	ppmw	GDMS	≤0.1	≤0.1
Mg	ppmw	GDMS	≤1.0	≤0.1
Mn	ppmw	GDMS	≤1.0	≤0.3
Mo	ppmw	GDMS	≤4.0	≤0.5
Na	ppmw	GDMS	≤0.2	≤0.1
Ni	ppmw	GDMS	≤5.0	≤0.5
Pb	ppmw	GDMS	≤2.0	≤0.1
Si	ppmw	GDMS	≤5.0	≤2.0
Sn	ppmw	GDMS	≤2.0	≤1.0
Th	ppmw	GDMS	≤0.001	≤0.001
U	ppmw	GDMS	≤0.001	≤0.001
V	ppmw	GDMS	≤1.0	≤1.0
W	ppmw	GDMS	≤1.0	≤0.5
Zn	ppmw	GDMS	≤1.0	≤0.5
Zr	ppmw	GDMS	≤5.0	≤1.0
Total amount	ppmw		≤50	≤10