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Standard Specification for Refractory Silicide Sputtering Targets for Microelectronic Applications[1]

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1. Scope

1.1 This specification covers sputtering targets fabricated from metallic silicides (molybdenum silicide, tantalum silicide, titanium silicide, and tungsten silicide). These targets are referred to as refractory silicide targets, and are intended for use in microelectronic applications.

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

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *raw material lot*—powder mix lot from which a number of targets is fabricated.

2.1.2 *relative density*—actual target density related to theoretical density, (see 3.1.3), stated as percent.

2.1.3 *theoretical density*—calculated density for given composition as described in 5.3.

3. Ordering Information

3.1 Orders for these targets shall include the following:

3.1.1 Type and ratio (see 4.1 and 4.2),

3.1.2 Whether low alpha grade is required, (see 4.4),

3.1.3 Minimum relative density, if other than 90 %, (see 5.1),

3.1.4 Configuration, (see 6.1),

3.1.5 Whether certification is required, (see 10.1).

4. Chemical Composition

4.1 *Type*—Targets shall be classified by the following major constituents:

4.1.1 Molybdenum silicide, (Mo/Si),

4.1.2 Tantalum silicide, (Ta/Si),

4.1.3 Titanium silicide, (Ti/Si), and

4.1.4 Tungsten silicide, (W/Si).

4.2 *Ratio*—Target composition shall be stated as the atomic ratio of silicon to metal, such as Ta/Si 2.5. Ratio tolerance shall be ± 0.1. Therefore, the acceptable range for a 2.5 target would be 2.4 to 2.6.

NOTE 1—Silicon content may be calculated from the following formula:

$$\text{Silicon, \%} = \frac{\text{Ratio} \times A}{(\text{Ratio} \times A) + B} \times 100$$

where:

A = atomic weight of silicon, and

B = atomic weight of metal, (see Table 1[2-4]).

4.3 *Impurities*—Maximum impurity levels shall conform to the requirements prescribed in Table 2.

4.4 *Low Alpha Grade*—When low alpha grade targets are ordered they shall contain a maximum impurity level of uranium and thorium as agreed upon by the supplier and the purchaser. The method of analysis for these elements shall also be agreed upon.

NOTE 2—An alternative method for defining low alpha grade targets is to specify an alpha-emission rate. Specific methodology and emission rate shall be agreed upon by supplier and purchaser.

4.5 When required by purchaser, supplier will provide a 25 g sample of material that is representative of the total production process for the particular raw material lot, (see Section 8).

5. Physical Properties

5.1 Minimum relative density shall be 90 %. Other relative densities may be specified by the purchaser.

5.2 Actual target density shall be determined by Archimedes principle or other acceptable techniques.

[1] This specification is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.17 on Sputter Metallization.

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[2] Molybdenum disilicide and WSi_2 (equilibrim tetragonal phase) densities were computed from crystal lattice parameters tabulated in "Crystal Data-Determinative Tables, Third Edition," Vol 2, U. S. Department of Commerce, National Bureau of Standards and the Joint Committee on Powder Diffraction Standards, 1973, and JCPDS Data File Number 11-195. Tantalum disilicide (hexagonal) and α-$TiSi_2$ (orthorhombic) data are from Einspruch, N. G. and Larrabee, G. B., *VLSI Electronics Microstructure Science*, Vol 6, Table A.1, Academic Press, NY, NY, 1983.

[3] *Binary Alloy Phase Diagrams*, Vol 2, ASM, Metals Park, OH.

[4] Einspruch, N. G., and Larrabee, G. B., *VLSI Electronics Microstructure Science*, Vol 6, Table A.1, Academic Press, NY, NY, 1983.