SAES Smart Materials, Inc.
a SAES Group company

4355 Middle Settlement Road
New Hartford, NY 13413
P: 315.266.2026
F: 315.266.2027
www.shape-memory-alloys.com

Method for Certification of Inclusion Pursuant to ASTM F2063

SAES Smart Materials' inclusion analysis method is covered by three revision controlled procedures in our Corporate Procedures Manual. One covers the Nitinol Bar and Coil Sampling Plans, one covers the Metallographic Procedure for Nickel - Titanium Alloys and one covers the Determination of Size and Percent Area of Non - Metallic Inclusions in Nitinol Samples.

ASTM F2063, Paragraph 9.2.4 requires that the supplier and the purchaser agree "upon the number and location of the samples in the product, the sample preparation, the number of fields of view and the measurement technique" [for inclusion analysis]. This is a synopsis of our test method for certification of the inclusion content and stipulates the parameters listed above.

1. Each Nitinol heat is a single vacuum arc re-melted ingot.
2. Each ingot is sampled for microcleanliness at the pre-rolled size for bar products. This is 2 inch round cornered square. For coil and wire products samples are taken at ¼" diameter x coil.
3. Each ingot is samples in three locations corresponding to the bottom, middle and top of the ingot product.
4. The samples are taken per SSM N.MFG.018.03. The samples are from the bottom of the first bar or coil, the top of the middle bar or coil and the top of the top bar or coil from each ingot product.
5. The plane of polish is at the longitudinal centerline of the bar or coil. The bar sample is 1/2" long in the longitudinal direction and 1" high in the transverse direction. The coil sample is approximately 3/4" long x full diameter.
6. The sample is polished per SSM N.INS.017.03 in stages through 60 grit paper, 120 grit paper, 180 grit paper, 220 grit paper, 9 micron diamond and finally 3 micron diamond.
7. The sample is examined at 500 diameters magnification in the as-polished condition, per SSM N.INS.016.03.
8. The inclusion content is evaluated by scanning the length of the sample at 500X and looking for the largest inclusion and/or the largest area density of inclusions in three regions - the centerline, the mid-radius line and the edge of the product cross section.
9. Three fields of view are photographed in each region. The three fields are chosen by the metallographer to show the largest inclusion and/or the largest area density of inclusions observed.
10. The metallographer switches between the optical image and the video image and adjusts the video system to capture the image of all particles larger than 0.1 micron in the field of view.
11. The 9 video images for each sample are saved to the computer with the optical pictures.
12. The 9 video images are analyzed by the computer program.
13. The quantitative metallographic program measures and records the largest dimension of each particle imaged to the computer.
14. The largest dimension recorded for all of the particles imaged in the 27 fields of view for each ingot is reported for certification per F2063.
15. The quantitative metallographic program calculates the average dimension for each inclusion imaged to the computer.
16. The average dimension of each inclusion is used as a diameter to calculate the area of an equivalent round particle. The area of all of the particles imaged is summed and divided by the total area of the image to calculate the area fraction of the inclusions.
17. The largest area fraction of the 27 images analyzed is reported for certification per F2063.