

Analytical Solutions

May 9, 2007 (Version 2.0)

for BioTechnology

BN 1500

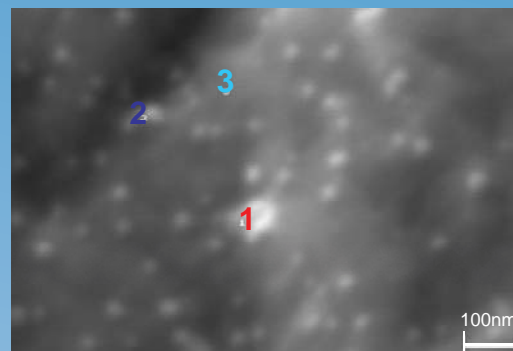
Stainless Steel Corrosion: Medical Device Applications with Auger Electron Spectroscopy (AES) Analysis

Background

Stainless steel is used extensively in the biomedical industry including catheters, stents, screws, tubing, guidewires, dental products, orthopedics and a wide variety of medical instruments. Stainless steel is often the metal of choice because of its resistance to corrosion. However, corrosion can still occur depending on factors such as the grade of stainless, the quality of the passivation layer, the contaminants present on the surface, and the environment the stainless is exposed to.

Auger Electron Spectroscopy (AES) analysis can be effective in determining the quality of passivation layers used to prevent corrosion. In addition, if corrosion does occur, AES analysis can be instrumental in determining its cause.

AES analysis is capable of detecting very localized corrosion and potential causes, as shown in the following case study



SEM

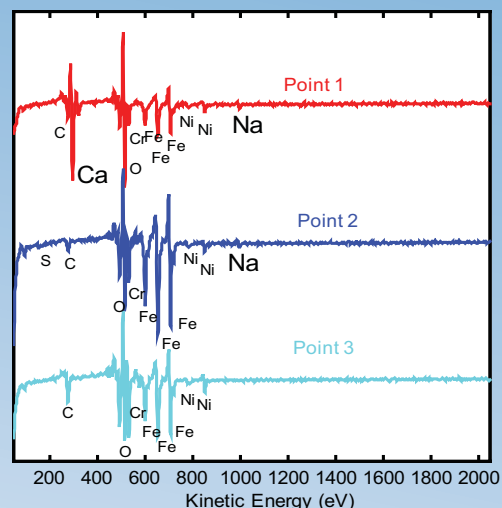


Table 1. AES Atomic Concentrations (atom%)

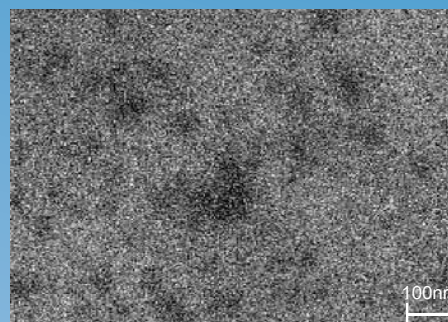
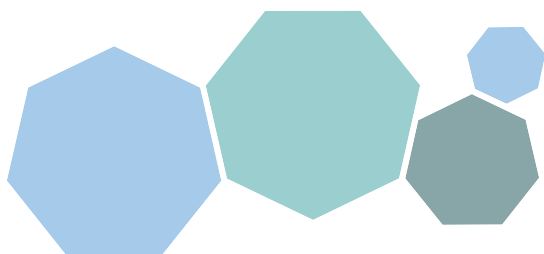
Sample	C	O	Na	S	Ca	Cr	Fe	Ni
Point 1 - large defect	13.1	30.2	3.5	-	38.0	3.4	10.0	1.9
Point 2 - small defect	8.6	35.2	5.6	0.5	-	9.7	37.9	2.6
Point 3 - control area	21.4	33.4	-	-	-	16.7	24.1	4.5

Results & Discussion

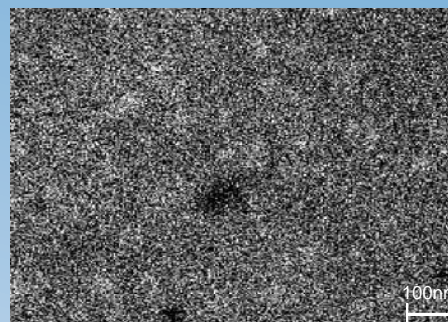
Figure 1 shows a high magnification secondary electron micrograph (100,000X magnification) obtained from an Auger instrument on the as-received surface of a piece of 300 series stainless steel sheet. The micrograph shows a series of extremely small defects, most of which being only about 25nm in diameter. This SEM image was used to define points on which Auger electron spectroscopy was to be performed. One large and one small particle (points 1 and 2, respectively) were analyzed along with a control region (point 3) off of the defects. All three of the survey spectra show the presence of the expected C, O, Cr, Fe and Ni from the air-exposed stainless steel surface. In addition, the spectrum from point 1 (larger defect) shows the presence of a large amount of Ca along with a smaller Na peak. The Auger spectrum from the small defect (point 2) shows the presence of S and Na contaminants but also shows much different Fe to Cr peak ratios than the spectrum from the control area (point 3). Quantification of the elements detected from these three points is shown in Table 1. Auger maps were acquired for several of the elements of interest including Ca, Cr, and Fe. The map for Ca reveals a lateral distribution of Ca within a 1mm² field of view

Summary

Although scores of particle defects were observed in the SEM image, only a few of them appear to have significant Ca, as shown in the Ca Auger map. Most of the smaller particles correspond to larger concentrations of Fe, compared to the background area (Point 3). This indicates that localized corrosion has occurred within these 25nm-sized defects with an obvious potential cause being the presence of Na.



Cr AES Map



Fe AES Map



Ca AES Map

United States Locations

Tempe, Arizona
+1 480 239 0602 info.az@eaglabs.com
+1 602 470 2655 fax

Sunnyvale, California
810 Kifer Road
+1 408 530 3500 info.ca@eaglabs.com
+1 408 530 3501 fax

1135 E Arques Avenue
+1 408 738 3033
+1 408 530 3035 fax

785 Lucerne Drive
+1 408 737 3892
+1 408 737 3916 fax

Peabody, Massachusetts
+1 978 278 9500 info.ma@eaglabs.com
+1 978 278 9501 fax

Chanhassen, Minnesota
+1 952 828 6411 info.mn@eaglabs.com
+1 952 828 6449 fax

East Windsor, New Jersey
+1 609 371 4800 info.nj@eaglabs.com
+1 609 371 5666 fax

Syracuse, New York
+1 315 431 9900 info.ny@eaglabs.com
+1 315 431 9800 fax

Raleigh, North Carolina
+1 919 829 7041 info.nc@eaglabs.com
+1 919 829 5518 fax

Round Rock, Texas
+1 512 671 9500 info.tx@eaglabs.com
+1 512 671 9501 fax

International Locations

Shanghai, China
+ 86 21 6879 6088 info.cn@eaglabs.com
+ 86 21 6879 9086 fax

Tournefeuille, France
+ 33 5 61 73 15 29 info.fr@eaglabs.com
+ 33 5 61 73 15 67 fax

Frankfurt, Germany
+ 49 (0) 693053213 info.de@eaglabs.com
+ 49 (0) 69307941 fax

Tokyo, Japan
+ 81 3 5396 0531 info.jp@eaglabs.com
+ 81 3 5396 1930 fax

HsinChu, Taiwan
+ 886 3 5632303 info.tw@eaglabs.com
+ 886 3 5632306 fax

Uxbridge, United Kingdom
+ 44 (0) 1895 811194 info.uk@eaglabs.com
+ 44 (0) 1895 810350 fax