

Laboratory Report

November 6, 2023

Report No. 16939

Analysis of ID of Tube, TP316L, 12.7*1.24, EP Sample



[Rocky Mountain Laboratories, Inc.](#)



Rocky Mountain Laboratories, Inc.

602 Park Point Drive, Suite 101

Golden, Colorado 80401

(800) PRO-LABS www.RockyMountainLabs.com

November 6, 2023

Cara Chang
Huzhou Zhongrui Cleaning Technology Co., Ltd.
No 99 Zhengxing Road
Shuanglin Township
Huzhou, Zhejiang, China

Re: Report No. 16939: Analysis of ID of Tube, TP316L, 12.7*1.24, EP Sample

Analyst: Principal Investigator
[Patrick R. Stevens, Ph.D.](#)
Analytical Chemist

Reviewed By
[Marilyn M. Andrews](#)
Materials Science Engineer

Background: One sample consisting of a section of a stainless steel Tube was delivered. The label on the sample bag had the following information, "Tube, TP316L, 12.7*1.24, EP" so that was the name used for the sample through the report. Analysis of the inside diameter (ID) surface of the sample by X-ray Photoelectron Spectroscopy (XPS) after a pre-sputter to remove 15 Å of material was requested. It was also requested that an image of the ID surface of the sample be acquired by Scanning Electron Microscopy (SEM) at 150X.

Analysis: The sample was cut to size using a hack saw while being careful not to heat the sample up while cutting. The ID of the sample was then analyzed. X-ray Photoelectron Spectroscopy (XPS), also referred to as Electron Spectroscopy for Chemical Analysis (ESCA), was performed on the sample after a sputter etch to remove approximately 15 Å of surface material. XPS is an elemental analysis technique which is capable of detecting all elements except for H and He and has a nominal detection limit of ~0.1 atom%. Spectral interferences may prohibit the detection of some elements in relatively low concentrations. The sample was measured at a 90° Take-Off-Angle (TOA) yielding a sampling depth of ~10 nm. The analysis area was ~500 µm in diameter. Analysis was performed with a monochromatic Al $K\alpha$ x-ray source. The quantification method assumes that the sampling volume is homogeneous, which is rarely the case; thus, tables of relative elemental compositions are provided as a means to compare similar samples and to identify contaminants and are not meant to provide accurate compositional data. Accurate quantification of data can be achieved through the use of well characterized reference materials of similar composition to the unknown sample.

Scanning Electron Microscopy (SEM) was performed on the ID of the sample. SEM images depict topographic features of the sample surface. SEM imaging was performed at 15 keV.

<u>Figure</u>	<u>Description of Analysis</u>
1	XPS survey spectrum of Tube, TP316L, 12.7*1.24, EP
2	SEM image of Tube, TP316L, 12.7*1.24, EP, 150X

Results and Interpretation:

Relative Elemental Composition of Tube, TP316L, 12.7*1.24, EP
Sample Surface as Determined by XPS
[Atom %]

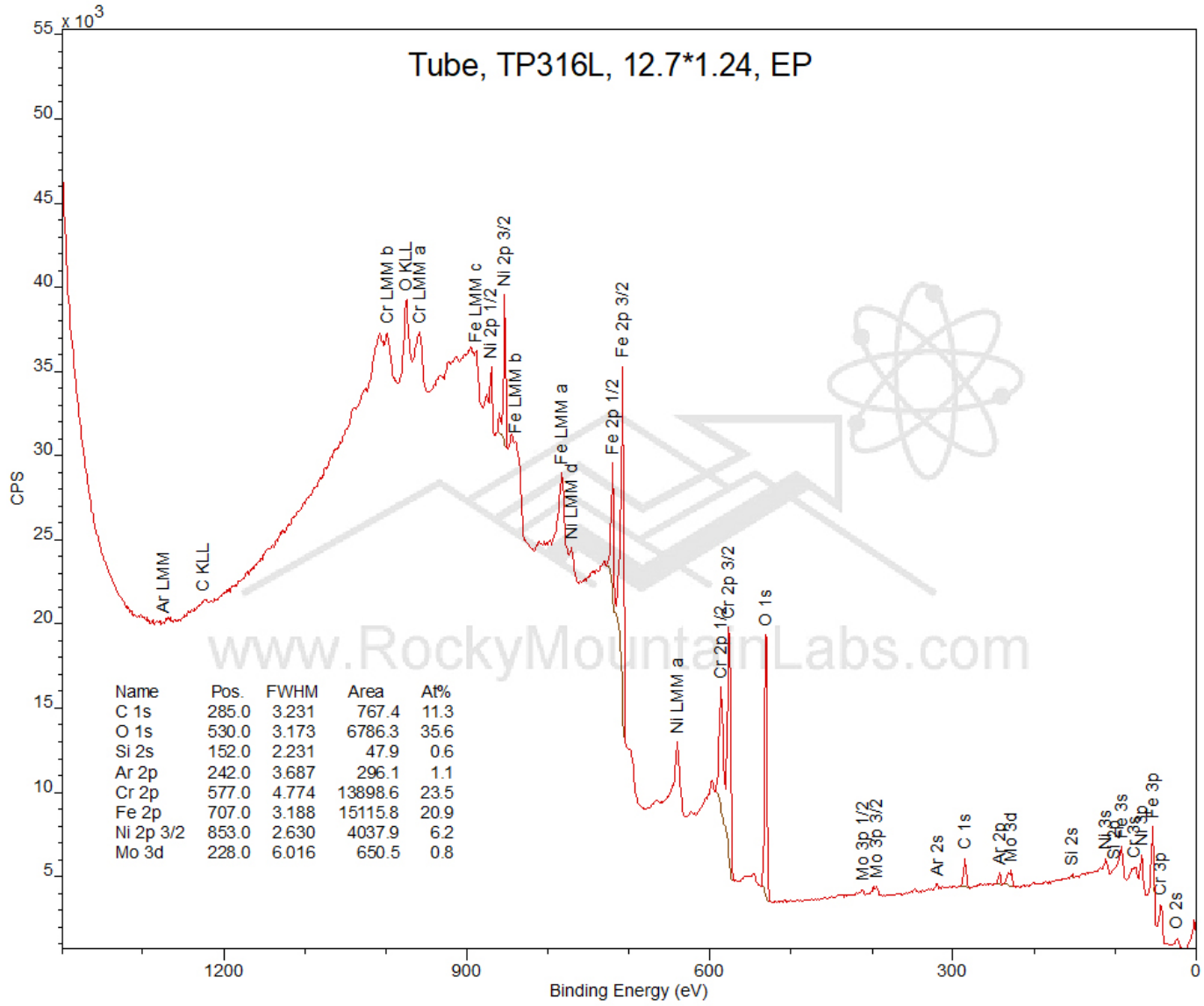
C	O	Si	Ar*	Cr	Fe	Ni	Mo	Cr : Fe
11.3	35.6	0.6	1.1	23.5	20.9	6.2	0.8	1.12 : 1

* Argon (Ar) likely present due to ion implantation during sputter etch process

General observations:

- * The chromium to iron (Cr : Fe) ratio is greater than 1 : 1 for the Tube, TP316L, 12.7*1.24, EP Sample.
- * The requested SEM image at 150X is presented in [Figure 2](#).

We have pride in our work. If you notice any errors or omissions in this report, please contact the Principal Investigator. If you have additional questions not addressed by this report, please contact the Principal Investigator for further discussion.



www.RockyMountainLabs.com

Figure 1: XPS survey spectrum of Tube, TP316L, 12.7*1.24, EP

Report No. 16939
November 6, 2023

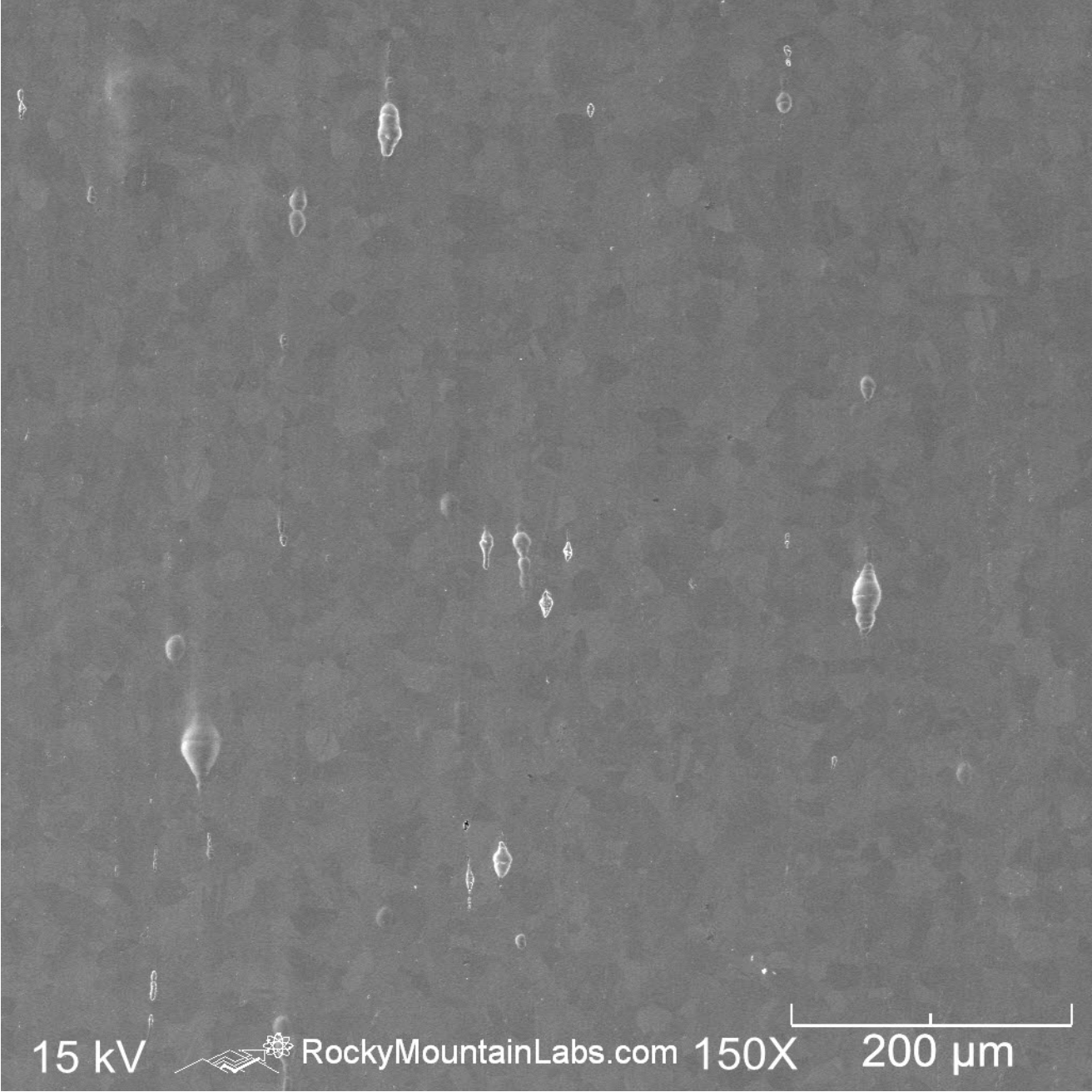


Figure 2: SEM image of Tube, TP316L, 12.7*1.24, EP, 150X