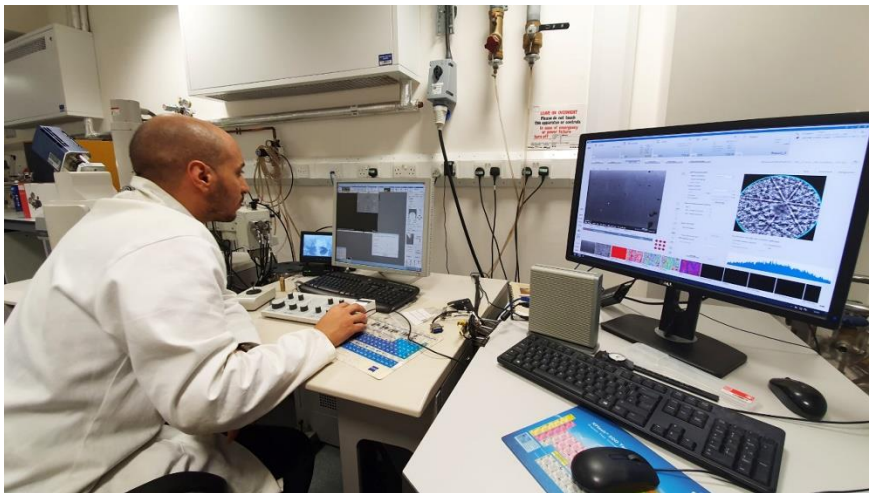


MetPrep Application Notes – Application Note – 005

The use of Vibratory Polishing in the Preparation of Stainless Steel Type 316L



Kevin Smith - March 2020

Introduction

The preparation of Stainless Steels is relatively straight forward but trying to obtain a surface finish for Electron Back-Scatter Diffraction (EBSD) can be a little more difficult. Care has to be taken to ensure the surface is both damage free and also free from smearing. The latter can often be created by excess pressure & direction polishing. Thus creating a poor surface to obtain the correct EBSD data

EBSD is a technique based around a Scanning Electron Microscopy (SEM) that allows the some of the backscattered electrons of a sample struck with the focused electron beam to form Kikuchi bands. Evaluation at different points using a chosen pattern on the sample can create detailed textural information and generate images of multicoloured grains that indicate the orientation of the crystals within each grain. This allows full crystallographic analysis to be carried out.

The sample

MetPrep were once again approached by a student in the Department of Mechanical Engineering at Imperial College regarding the preparation of an Additively Manufactured Austenitic Stainless Steel Type 316L. The sample was prepared according to Table 1 below and appeared visually OK.

Table 1. Auto-polisher settings

Step	Type	Solution/Suspension	Load	Speed (direction)	Time
1	P180	H ₂ O	20 N	150 RPM (comp)	3 min
2	P180	H ₂ O	20 N	150 RPM (comp)	90 s
3	P180	H ₂ O	20 N	150 RPM (comp)	90 s
4	P180	H ₂ O	20 N	150 RPM (comp)	90 s
5	Nylap Cloth	9µm Polycrystal diamond suspension	20 N	240 RPM (comp)	5 min
6	Plano Cloth	3µm Polycrystal diamond suspension	20 N	240 RPM (comp)	5 min
7	Alpha Cloth	1µm Polycrystal diamond suspension	5 N	150 RPM (comp)	3 min
8	Alpha Cloth	0.04µm non-crystallizing OPUS	5 N	150 RPM (counter)	5 min → cool → 5 min

Initial work whilst appearing to show a good surface finish optically produced an EBSD map with 3.93% zero solutions (Hit rate = 96.07%) as seen in Figure 1 below, highlighting the Inverse-Pole Figure (IPF) map, Image Quality (IQ) map, and Kikuchi bands.

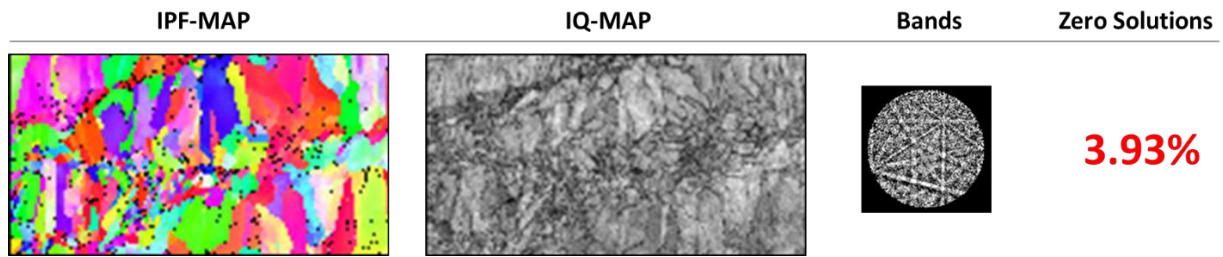


Figure 1. Initial EBSD results in the as prepared condition

Solution

To improve the hit-rate, the Saphir Vibro was employed as an additional final polishing stage using a low napped Multicloth final polishing and 0.04um OPUS Colloidal Silica. Initially just an hour was employed which increased the hit rate and also improved quality of the bands obtained (Figure 2).

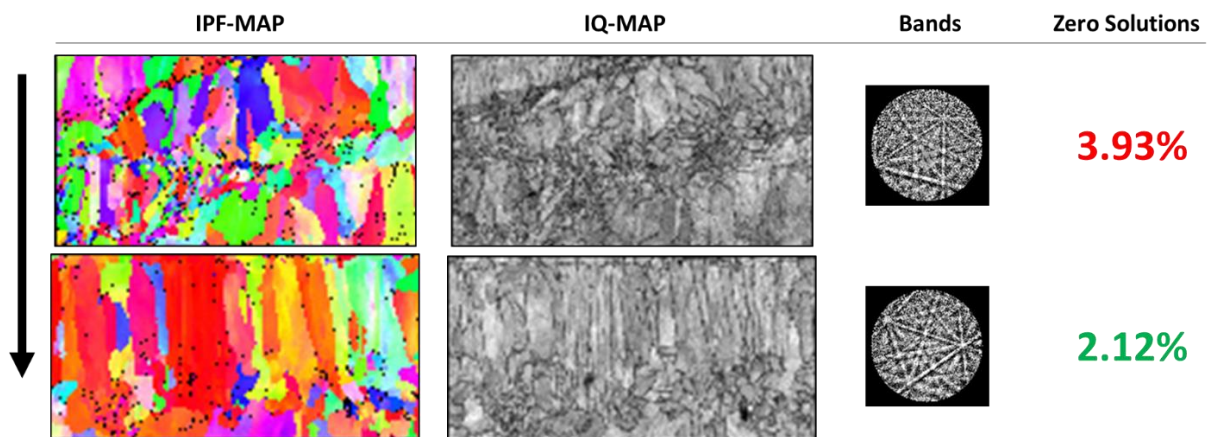


Figure 2. Comparison between the initial results versus with the additional 1-hour Saphir Vibro polishing

The number of zero-solutions was decreased from 3.93% down to 2.12%, which can be observed by looking at the reduction of the number of black pixels on the IPF-MAPs. In addition, the Kikuchi bands show of the Saphir Vibro processed specimen are sharper than that of the specimen prepared only using the auto-polisher.

Whilst the obvious improvement from vibratory polishing was good news it was decided to perform an additional polishing step by leaving the sample on the Saphir Vibro overnight (20 hours) to see how better the sample would become. The resulting EBSD map showed an improved hit rate of 98.49% (1.51% zero solutions) as shown in Figure 3 below.

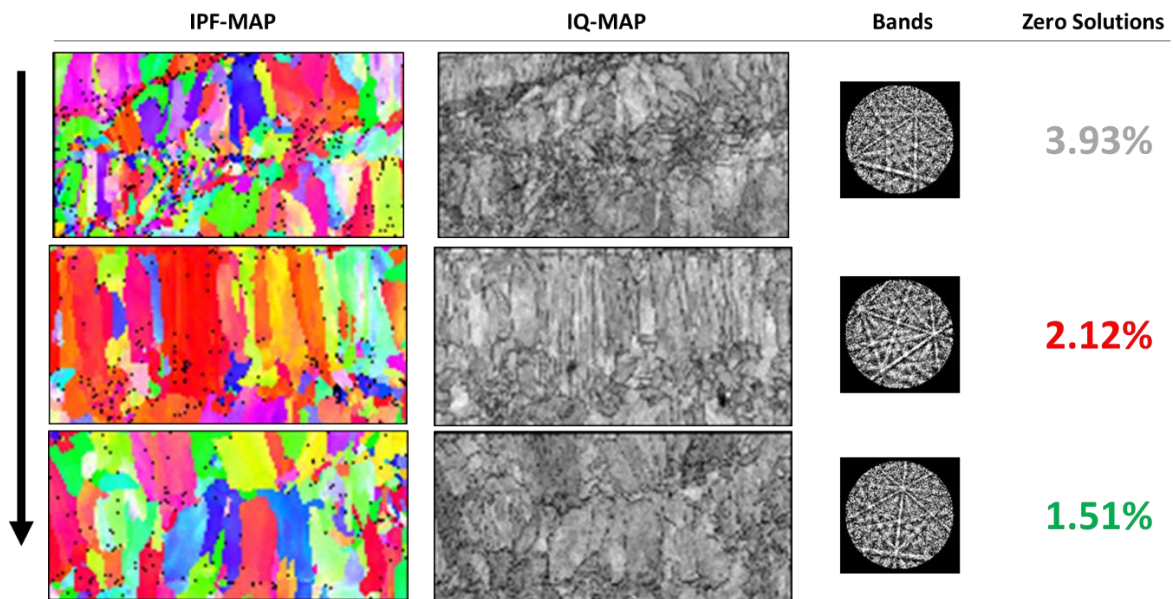


Figure 3. Comparison between the auto-polisher, 1-hour Saphir Vibro, and 20-hour Saphir Vibro

Summary

Whilst a tweak on the original preparation procedure might gain improved results it still appears that a just a small time on the Saphir Vibro increases the quality of the surface to be examined. A longer time only increases the surface quality and the quality of data obtained. The combination of Multicloth – OPUS Colloidal Silica on the Saphir Vibro makes a considerable difference on surface finish and more than acceptable to obtain good EBSD data.

Acknowledgements

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Additional information

The MetPrep web site can be found at <https://metprep.co.uk/>

Further information on the Saphir Vibro can be found here

<https://metprep.co.uk/product/vibratory-polisher/>

A video showing the operation of the Saphir Vibro can also be viewed on our YouTube Channel from the above page

Details concerning the Multicloth M our low napped final polishing cloth can be viewed here

<https://metprep.co.uk/wp-content/uploads/2016/03/TDS0030-Metprep-Final-Polishing-cloths-Multicloth-30.pdf>

Details of the OPUS colloidal Silica can be found here

<https://metprep.co.uk/wp-content/uploads/2016/06/TDS0047-Colloidal-Silica-Suspensions.pdf>

For any additional information please contact sales@metprep.co.uk or 02476 421222. You can also contact the author at kevin@metprep.co.uk or on 07768 475375