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Surface roughness measurement with an optical microscope

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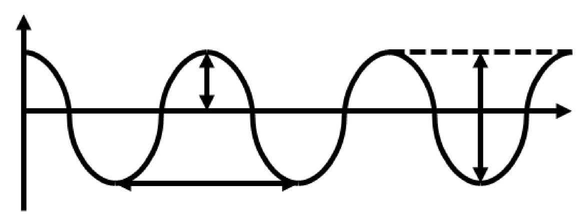
ABSTRACT

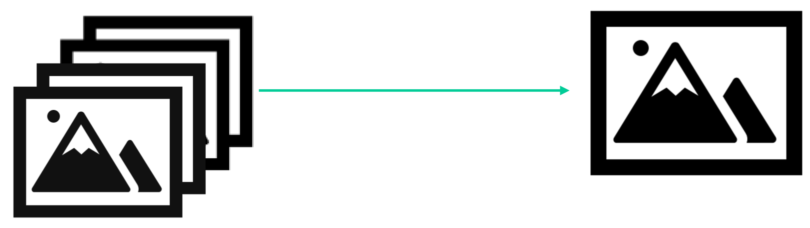
Improved adhesion between NiTi wires and polymer matrices constitutes a fundamental condition for successful additive manufacturing of composite parts using these materials as constituents. A possible strategy consists of creating crevasses at the surface of the metallic wires to promote anchoring to the matrix. To do so, it is possible to chemically attack the surface with an acid solution; however, the combined parameter variations allowable (e.g. acid concentrations and duration of exposure) are liable to result in a vast array of surface profiles warranting optimization. Under the aegis of the FIBR3D research project (POCI-01-0145-FEDER-016414), the present work deals with the development of a simplified method to analyse the surface roughness of the treated metallic wire surfaces in a reliable and timely manner through optical microscopy. Given that the use of a profilometer would take too much time, the authors resorted to measure the relevant roughness parameters through a Leica DMI 5000 M optical microscope (OM) capable of reconstructing a vertically correlated image through integration of a series of images of the same Region of Interest obtained with different focal planes. The relevant parameters evaluated with this technique were the arithmetic mean (RA), root mean square (RMS), maximum valley depth (Rv), maximum peak height (Rp), maximum height of the profile (Rt), together with the distances between consecutive peaks and consecutive valleys. To verify the reliability and accuracy of the optical measurement technique, its results were compared to those obtained with a profilometer over calibrated Vickers indentations performed over the surface of a high purity soft copper surface. Thus, simply requiring a set of optical imaging acquisitions, a series of statistically robust measurements may be obtained in order to quantify the surface roughness of the chemically treated NiTi wire surfaces.

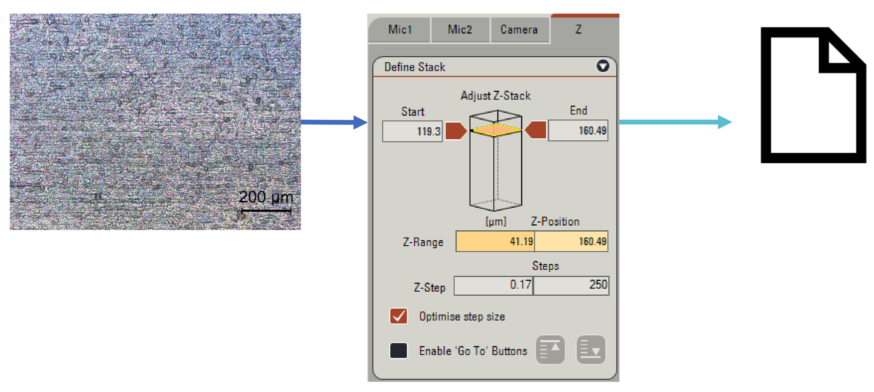
MATERIALS AND METHODS



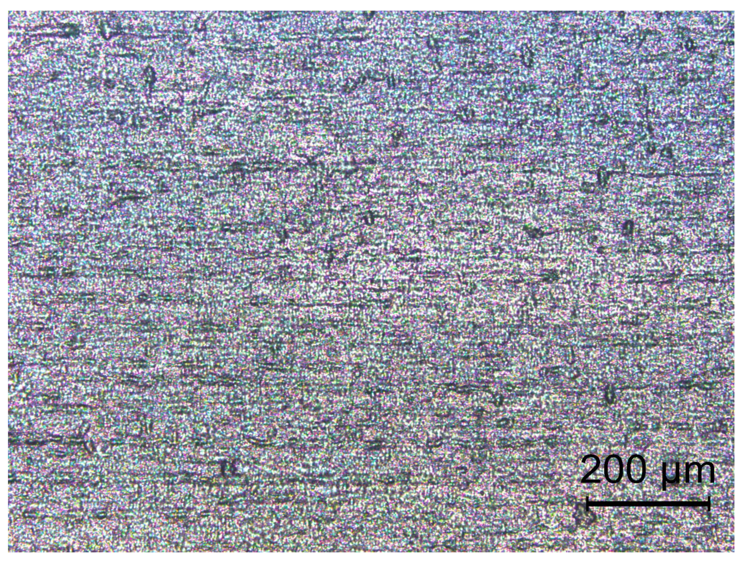
Profilometer
Atomic Force Microscope (AFM) / SEM

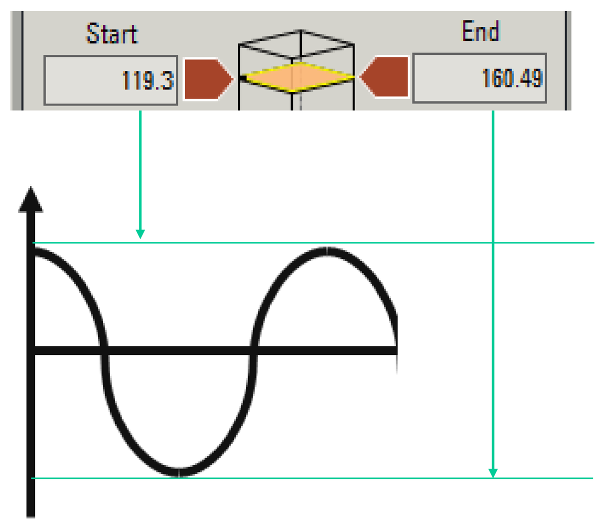
- ~~Profilometer~~
- ~~Atomic Force Microscope (AFM) / SEM~~
- Optical microscope (Leica DMI 5000 M)
- Leica LAS Multifocus Module – Allows the composition of images with different focal distances (z-step)

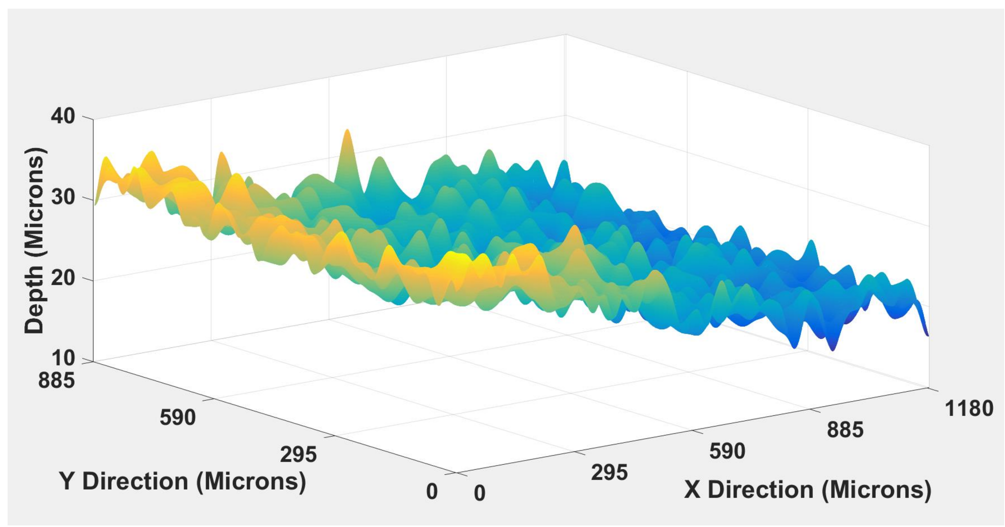


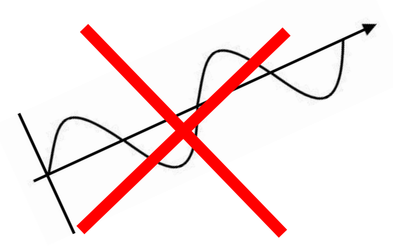


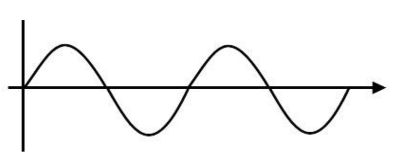
RESULTS AND DISCUSSION





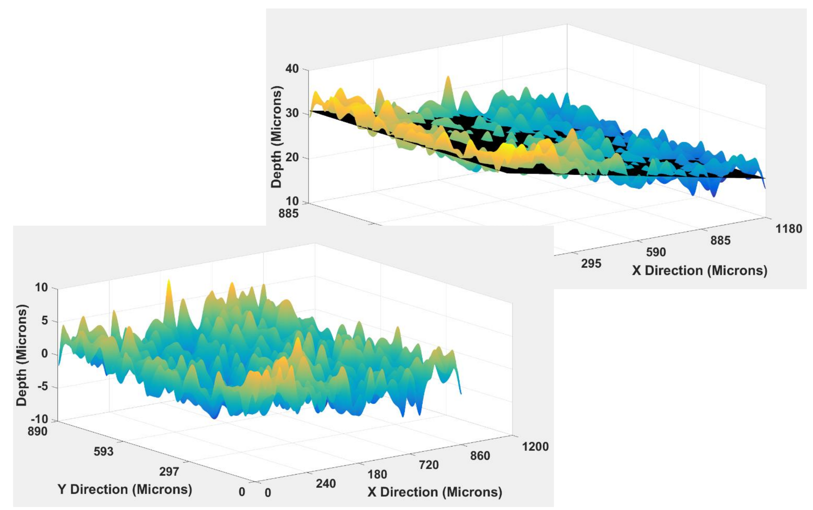


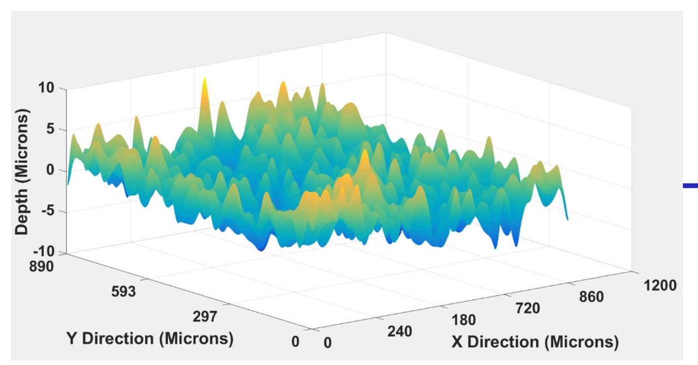




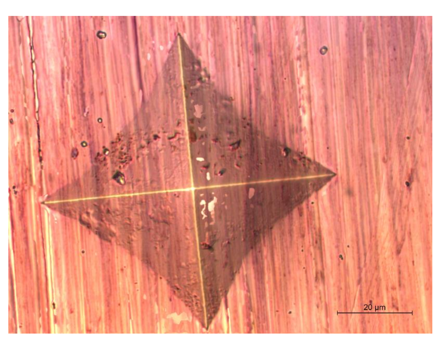
- *Curve Fitting Tool*
- *Center and scaled, first degree, polynomial equation of the type:*

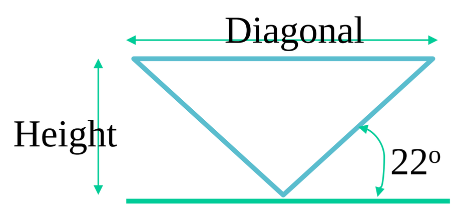
$$f(x,y) = C1 * x + c2 * y + C3$$



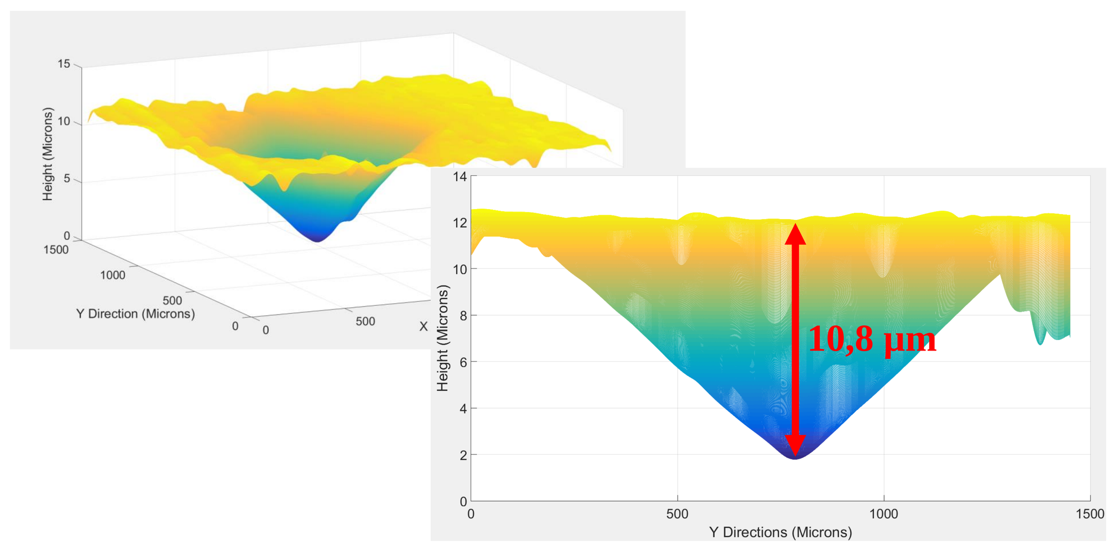


	Measure (Microns)
Ra	1,6
Rms	2
Rv	-6
Rp	9
Rt	15





	VH Machine		OM	
Diagonal	Size (µm)	Height (µm)	Size (µm)	Height (µm)
1	87,1	12,4	79	11,3
2				



CONCLUSIONS

1. A method for obtaining the average plane and minimizing the effects of sample non-orthogonality
2. A technique for easily obtaining roughness measures of relatively big areas with high accuracy in a short amount of time.

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