

Technical Cleanliness Analysis by Nanomanipulators- the Direct Method

Maroš Špirko, spirko.maros@gmail.com

ABSTRACT

Technical Cleanliness (TC) has been continually growing into ever-present discipline of industrial manufacturing. Following the trend of downsizing products, any contamination present in or on the finished product represents a danger that can severely affect its proper, intended functionality. Therefore, analytical methods capable to characterise particulate contamination are essential part of VDA 19 and ISO 16232 standards governing TC agenda.

Nanomanipulation is widely used for electric characterisation of circuits in the semiconductor manufacturing(quality-control). In this experiment design, the utilisation of nanomanipulators for electric characterisation of particulate contamination is shortly described.

Keywords· Technical Cleanliness · Contamination analysis· Particulate identification · Nanomanipulators· VDA 19· ISO 16232

Introduction

Technical Cleanliness and nanomanipulation are well known separate domains in the field of industrial manufacturing, while their combination into one useful method has not yet been described. This short communication aims to deliver initial Proof of Concept measurement as a hint for further development of this method.

1. Materials and methods

1.1 Sample, probes and the apparatus

The Wolfram material was used as a sample. A particle was placed on Jomesa filter and was thus known to be a conductive sample. The Omniprobe nanomanipulator needles (made also from Wolfram) were used (PN: PT-0001.02.01) with the probe tip of 0.5 μm . Neither the sample nor the probe tips were pre-treated in any way.

For imaging and measurement, the Tescan Lyra 3 SEM microscope with installed SmarAct nanomanipulators and picoampere meter was used.

2. Results and discussion

2.1 Contacting the particle and I-V curve measurement

The Jomesa filter with embedded wolfram particle was placed inside the SEM vacuum chamber to follow the same procedure as described in both standards mentioned above (standard analysis). As the sample was a known material the chemical analysis was not necessary to be performed in this case.

Subsequently, the manipulators approached the sample and contacted it in a way and position the measurement setting allowed. Afterwards, the I-V curve was recorded; - it's worth noting that for conductive samples simple measurement of Resistance, R , is sufficient. From the I-V curve the average value of resistance was calculated to be $R=1285 \text{ Ohm}$ for this particle.

Value of 1285 Ohm represents a relatively high value of resistance and could theoretically suggest that the investigated particle is rather semi-conductive. It's important to understand that this value represents resistance of the whole measurement system, with the main resistance contribution coming from the two contact points between the probes and the sample. This contact resistance depends on various factors like presence of oxides layer on the surface of both the needles and the sample, geometry of the sample and of the contact point, or from the force the needle presses the sample with. As this experiment is solely initial evidence of measurement possibility, all these variables need to be investigated more in detail in further studies.

3. Conclusions

This short Proof-of-Concept experiment has shown pertinence of nanomanipulation for the field of Technical Cleanliness. Particles of interest can be approached and contacted for direct measurement of their electrical properties, namely resistance and/or conductance. Putting an emphasis on the electronics and electric-vehicles manufacturing industries, this information can be of immense value when evaluating risks the metallic(conductive) and semi-conductive particles may pose for proper functionality of final products.

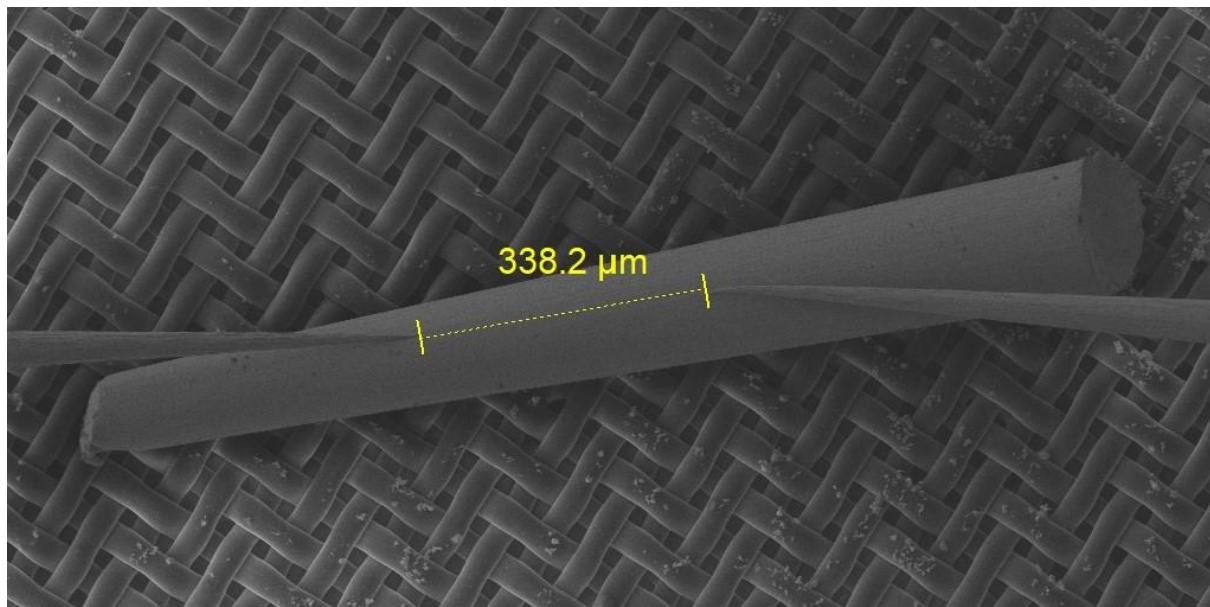


Figure 1. Contacting the Wolfram particle with nanomanipulator needles

I-V curve

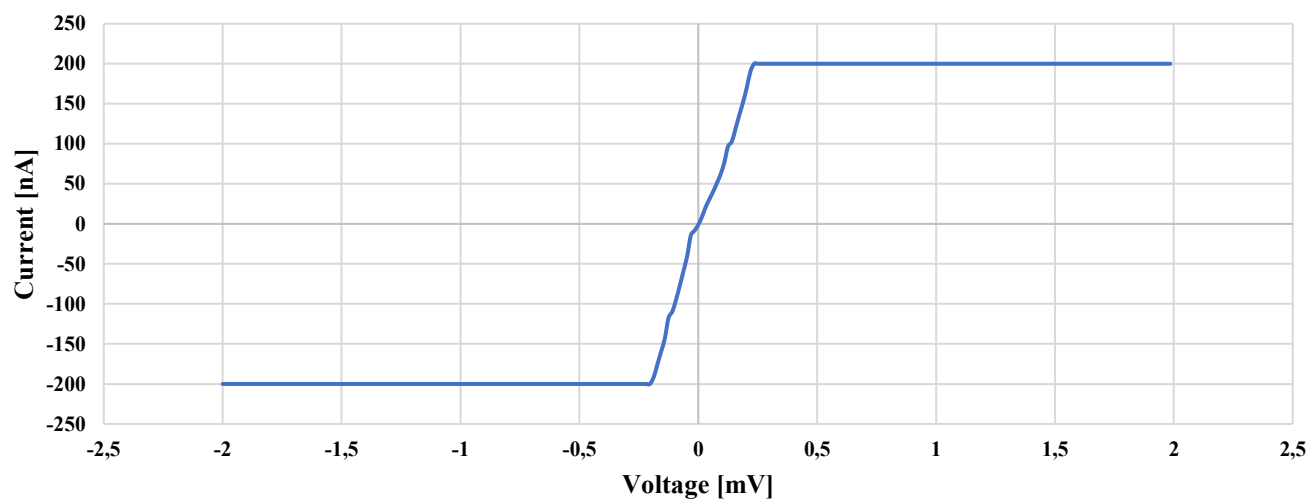


Figure 2. I-V curve of the Wolfram particle

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