Application Note

Topography Analysis of Ni-Foam Specimen using AMETEK VersaSCAN: Optical Surface Profiler (OSP)

Application Note: 2024

Introduction

Measuring the topography of non-homogeneous electrode surfaces is crucial because it provides detailed information about surface roughness, morphology, and structural features. This knowledge is important for understanding and optimizing the performance of electrodes in various applications, including:

1. Batteries: Enhancing charge storage and efficiency.
2. Fuel Cells: Improving catalytic activity and durability.
3. Electrochemical Sensors: Increasing sensitivity and accuracy.
4. Corrosion Studies: Identifying areas prone to corrosion.

Accurate topographical analysis helps in designing better materials and improving device performance across these applications

This application note provides a guideline for measuring the topography of non-homogeneous electrode surfaces, such as a Ni-foam specimen using the AMETEK's VersaSCAN Optical Surface Profiler. Ni-foam, known for its high porosity and unique structure, requires precise topographical analysis for various applications ranging from catalysis to energy storage. The AMETEK VersaSCAN offers advanced optical profiling capabilities suitable for characterizing the surface morphology of such complex samples.

Instrumentation

The AMETEK VersaSCAN Optical Surface Profiler combines high-resolution optics with precision motion control to provide accurate surface measurements. The OSP technique uses a diffuse reflection mechanism to measure the topography of a sample. It can be used to measure topography, as a very sensitive leveling mechanism, or charting topography to be implemented with other scanning probe techniques for constant-distance mode operation.

Procedure

1. Instrument Setup:

- Mount the VS-OSP Laser Head assembly on VersaSCAN motion stage and connect the cable to the system box as indicated in the user manual.
- Power on the System Box and allow it to stabilize for a few minutes.
- Verify in the VersaSCAN software that an Ethernet communication is established.

2. Home routine/calibration:

- Perform the system home routine by clicking 'Manual Control' in the VersaSCAN software. Ensure that the motion stage is free from any specimen to move around freely in the X-, Y- and Z-axises.

3. Sample Preparation:

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- Ensure the Ni-foam sample is clean and free from any contaminants.
- Mount the sample securely onto the sample stage (nearly 4 cm below the OSP laser head), ensuring flatness and stability during measurements.

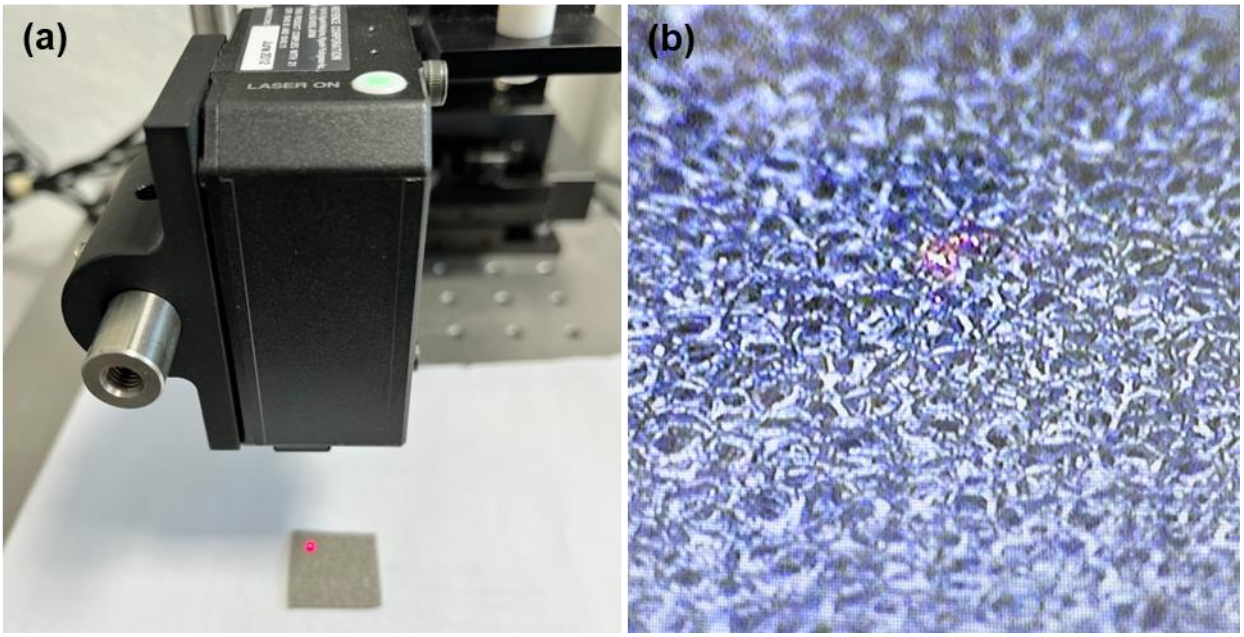
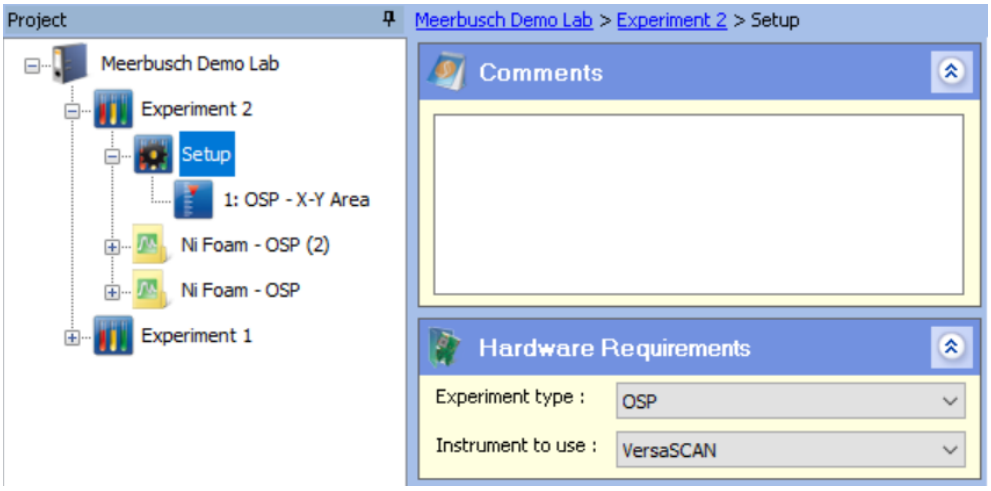


Figure 1. (a) VSC-OSP Laser Head over a Ni-foam specimen, (b) High-magnification image of Ni-foam captured by VSC-CAM

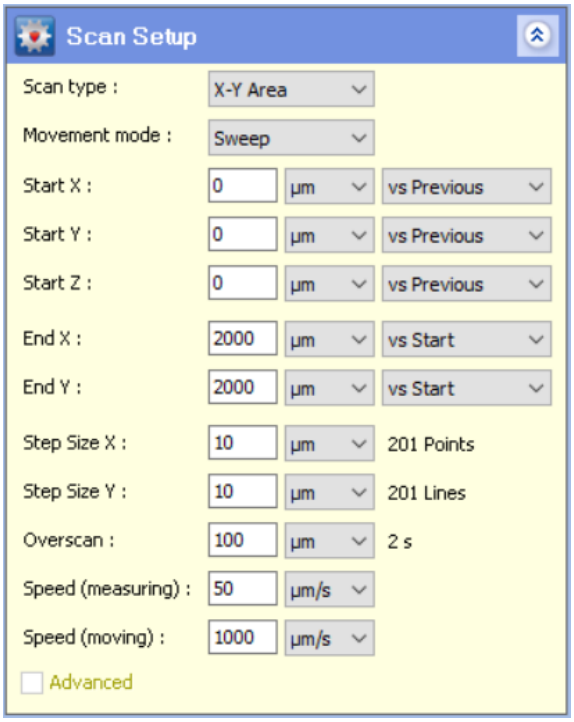
4. Acquisition Settings:

- Make a new Project and new Experiment, and in the Setup Experiment Type, Select 'OSP'.

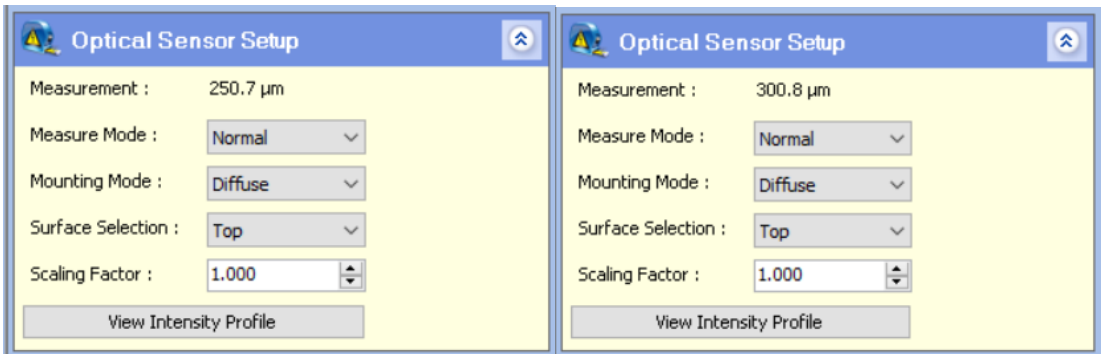


- Insert an OSP step and set the scan parameters including scan speed, step size, and number of scan lines based on the sample's surface characteristics and desired resolution.

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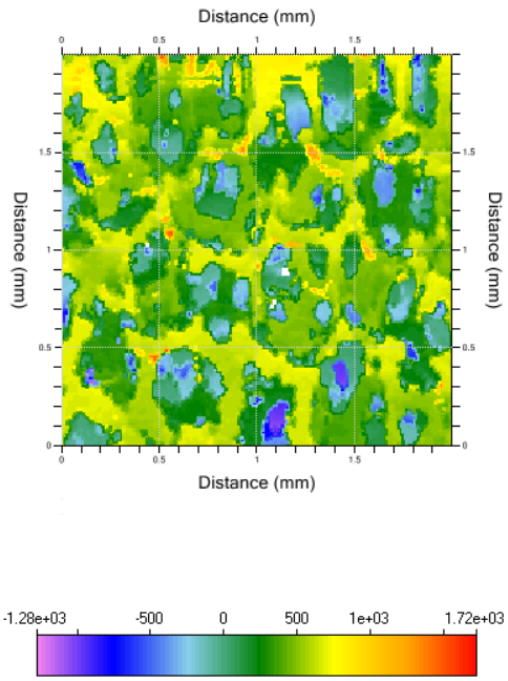
- Verify if the LED on top of the laser head shows a green color.
- If not, move the VS-OSP Laser Head in the positive or negative Z-direction using small steps through the Manual Control, until the sensor on the top of the VS-OSP Laser Head shows a Green Light. The progression is Blinking Amber → Solid Amber → Green → Solid Amber → Blinking Amber.
- Once the green light is stable, note the measured value under the Optical Sensor Setup.
- Move the Head up or down in the Z direction by a known value and use the known distance movement and the changed response in measurement to determine the scaling factor and input it into the Scaling Factor parameter.
- Here, the standard value of 1 worked out to be a fine scaling factor verified by moving the laser head by 50 µm.

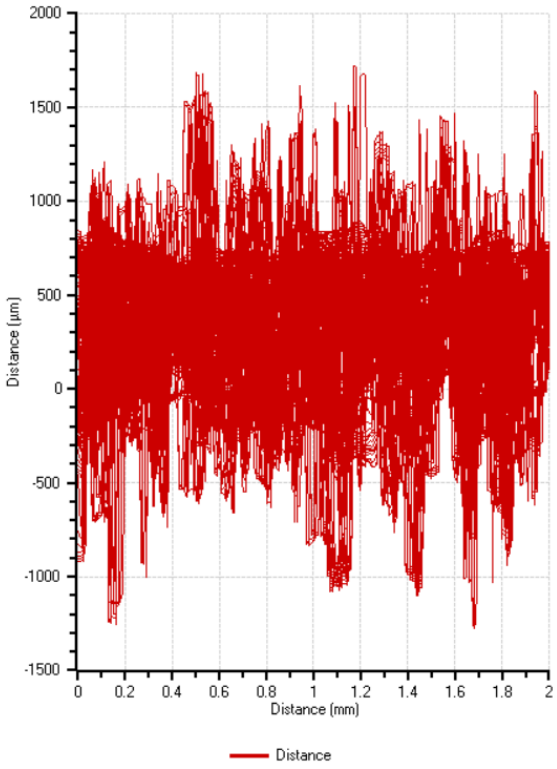


5. Data acquisition and analysis:

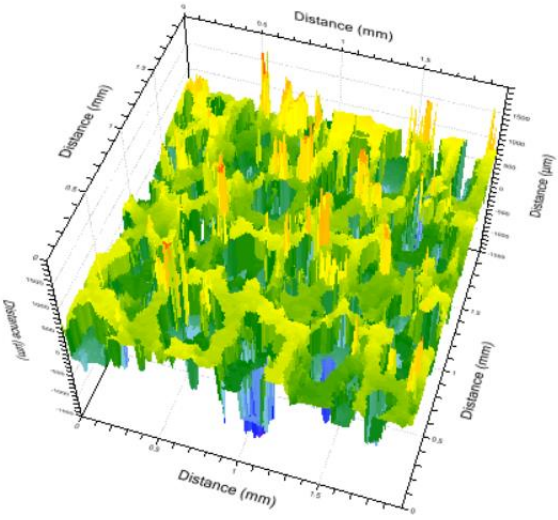
- Initiate scanning, allowing VersaSCAN to capture surface topography data.
- Ensure the scan covers the entire area of interest on the Ni-foam sample with sufficient overlap between adjacent scan lines.
- Generate 2D and 3D surface plots to visualize the topographical features of the Ni-foam sample.

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X = 1.01 mm
Y = 0.43 mm
Z = 705.65 µm





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Conclusion

The AMETEK VersaSCAN Optical Surface Profiler offers a powerful solution for characterizing the topography of electrode surfaces such as Ni-foam with high precision and resolution. By following the outlined procedure, researchers and engineers can obtain valuable insights into the surface morphology of their samples for a variety of applications in fields such as catalysis, energy storage, and material science.

Note: *Please refer to the instrument's user manual and follow safety guidelines when operating the equipment. For more information about our products and technical support, please visit us at www.ameteksi.com.*

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