Optical Inspection and Profiling of Defects on a Coated Wafer Surface

Nanoscale features are of paramount importance in microelectronics and semiconductor industry. To ensure the quality of the nanoscale features fabricated, wafers must be planarized and polished to achieve minimal surface roughness before and after coating applications. However, wafer coatings could have defects such as bumps, coating degradation, chipping, creases, dimples, particle contaminants, scratches, voids, etc. These coating defects can affect the fabrication of integrated circuits, lead to final devices not meeting specs or having premature mechanical failure. Surface coating defect inspection, identification, and classification thus are of great significance for improvement on quality, increase in yields and reduction in costs.

Optical profilometry is one of the top choices for coating inspection at the nano and micro scale for the microelectronics industry. The Wyko NT3300 Optical Profiler equipped at Ebatco's Nano Analytical and Testing Laboratory (NAT Lab) uses both vertical scanning interferometry and phase shift interferometry to characterize surface features. Sub-nanometer resolution in phase shift interferometry allows for precise surface feature and roughness analysis of smooth surfaces, while vertical scanning interferometry permits millimeter-sized object profiling and contouring. An obvious advantage of non-contact profilometry is its ability to make non-destructive and rapid analyses on specimen surfaces in contrast to contact based stylus measurements that are slow and that have to be in contact with the analysis surface.

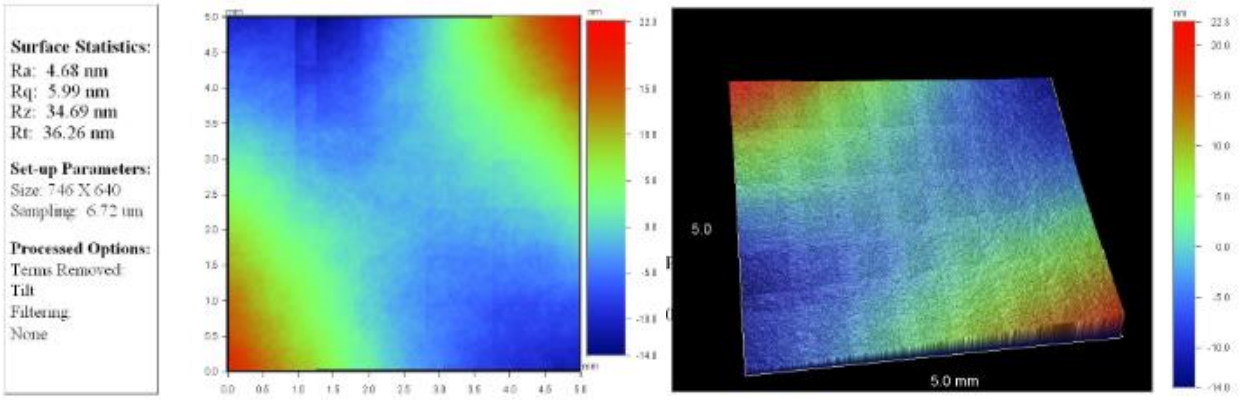

Figure 1. Optical profile (left) and 3D image (right) of a coated wafer area without defect.

Presented here are optical profiling images of a coated wafer surface at different locations. The left images show 2D profiles with surface roughness parameters of Ra, Rq, Rz, and Rt. The images on the right show 3D visualization of the specimen surfaces. As can be seen from these images the stitching function of the profilometer has made possible to cover large areas with high resolutions by stitching together multiple smaller scans.

In Figure 1, the 2D analysis and 3D rendering clearly shows a smooth and defect-free surface with roughness in the single digit nanometers. In contrast, Figures 2-4, present the 2D and 3D

characteristics of coating defects: scratches, pits, cracks and areas where there are raised features, possibly indicating residues or buildups on the coating surface.

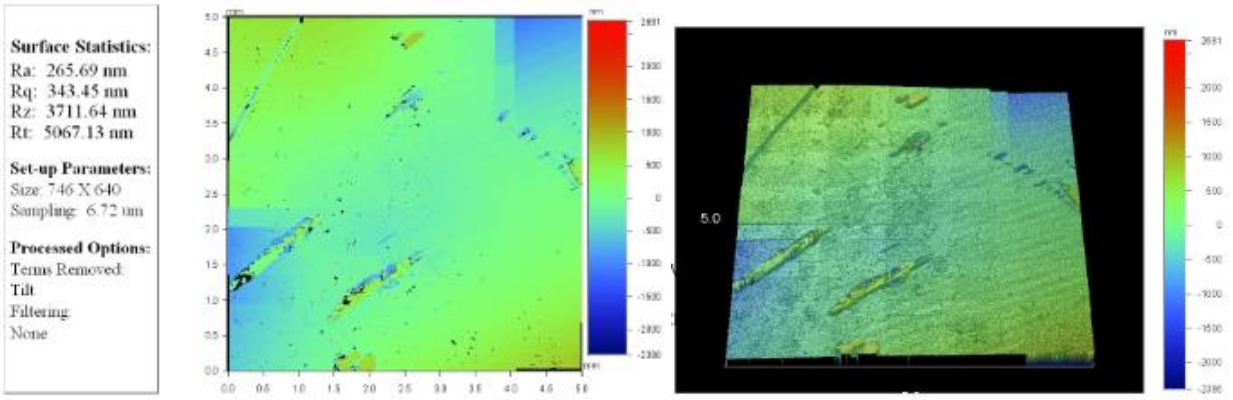

Figure 2. Optical profile (left) and 3D image (right) of a coated wafer area with scratches, and residues and buildups.

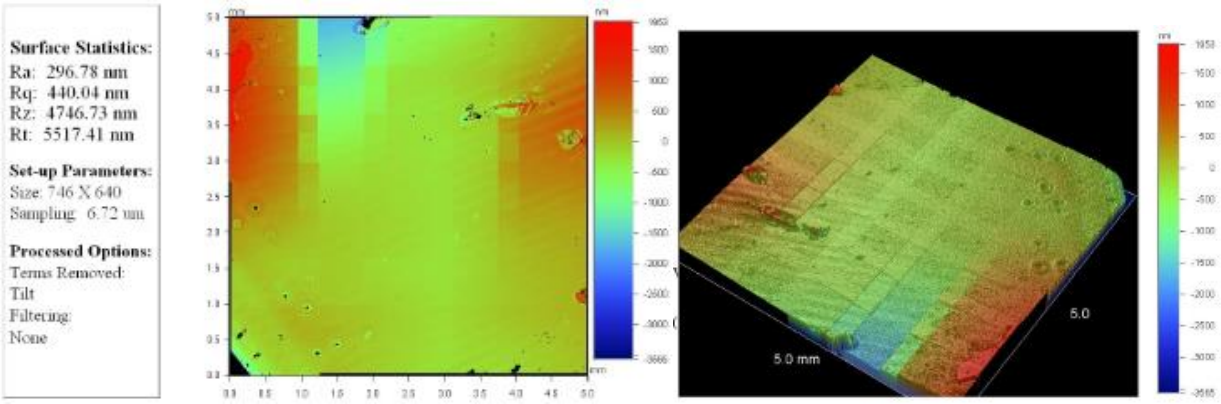

Figure 3. Optical profile (left) and 3D image (right) of a coated wafer area with pits.

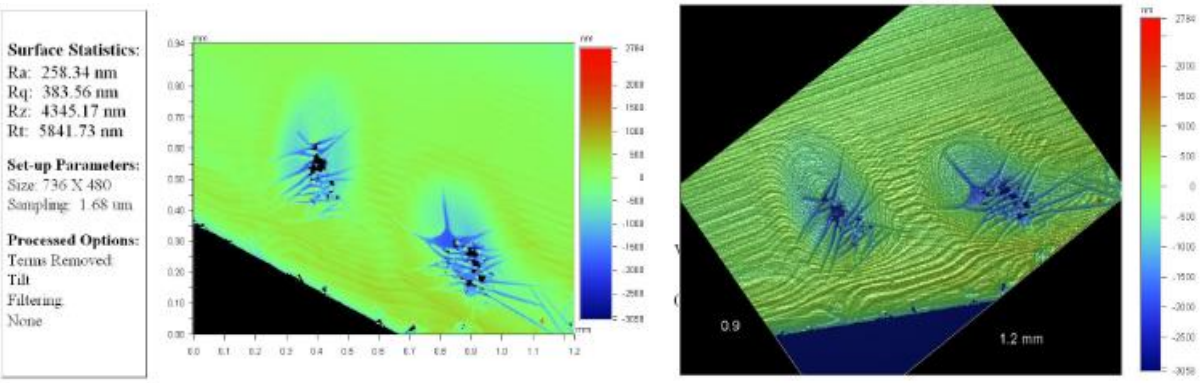

Figure 4. Optical profile (left) and 3D image (right) of a coated wafer area with cracks.