Towards Automation of Quantitative Analysis of Various Digital Images forMaterial and Process Characterization

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A large quantity of digitalimages is generated daily for material characterization and process monitoring/controlin semiconductor research and manufacturing. Various types of image capturing andimage generation tools are used. Cameras (i.e. image sensors) are used inoptical characterization in X-ray, UV, VIS, IRwavelength ranges. Electron microscopy uses image sensors to visualize theinteraction between electrons and materials of interest. Atomic forcemicroscopy (AFM) and wafer mapping tools generate pseudo digital images.Computer aided simulation and various analysis results are also exported asartificial digital images to visualize results. Every tool provides its ownimage export and analysis functions. Interpretation of identical digital imagedata is often subjectively, qualitatively and/or empirically analyzed. Theinterpretation of the data is often quite different among researchers,scientists and engineers, depending on their experience and areas of interest. Only a very small fraction of digital imagedata is utilized due to the lack of a reliable pattern recognition capabilityas well as user friendly image processing software.

It would be beneficial to develop end-userfriendly, unified image processing software which can support various digitalimage formats (such as BMP, JPG, PNG, GIF, TIF, DM3, ND2 etc.) from various imagecapturing and export tools. We often rely on our instinct and subjectivejudgment, even in scientific research. Useful data mining capabilities fromordinary digital images can greatly help researchers, scientists, engineers andstudents to effectively use digital image data and communicate dataobjectively. Statistical analysis of data gathered from ordinary digital imageswill enhance our understanding of the research subject. Correlation betweensimulation and experimental results can also be quantified.

In this paper, a newly developed end-userfriendly, unified image processing software (PicMan from WaferMasters, Inc.) isintroduced, along with a few digital image examples from the semiconductorindustry after plasma etching. Suggestions of the effective use of digitalimages in terms of quantitative and statistical analysis will be introducedusing sample images. The image processing software enables end users to analyzedigital images of any format, on their own PCs, very easily and accurately.Improved digital image analysis by end users will greatly improve theunderstanding of characterization results and shorten development cycles. The importanceof pattern recognition and strategies for repeated image data processingtowards data mining from big data through automation will be discussed.