Dynamic scatterometry for profile control during resist trimming process

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During the micro and nanofabrication processes more particularly for lithography or plasma etching, the CD (Critical Dimension) metrology is a key point to guarantee and secure the performance of the fabricated devices.

In-line process control requires real-time, non-destructive and non-invasive monitoring techniques. The conventional CD metrology techniques such as AFM (Atomic Force Microscopy) and CD-SEM (Secondary Electron Emission based technique) are not well suited for real time monitoring. Optical measurements are among the few solutions able to meet the requirements for in line monitoring. Scatterometry belongs to the optical strategies, it uses the analysis of the signature of the light scattered by a periodic structure to infer the shape of a feature (for example using spectroscopic ellipsometry).

In our laboratory, we have developed specific software and hardware tools to perform dynamic scatterometry, using *in situ* spectroscopic multi-wavelength ellipsometer[1].

The paper present the results of the application of dynamic scatterometry for the monitoring of two different resist trimming processes HBr/O_2 and Ar/O_2 plasma. A Jobin-Yvon ellipsometer, capable of real time acquisition of sixteen wavelengths, is plugged onto chamber of a Decoupled Plasma Source (DPS) from Applied Materials. The measurements are made in real time.

For validation purposes, the same process has been interrupted at several different times and the trimmed feature profiles have been measured using a 3D AFM from Veeco Instruments. Figure 3 how that the dynamic scatterometry provides reliable results and shows a great potential as a real time monitoring technique for etch process control. It can see that the dynamic scatterometry profile matches well the AFM data, both for CD and height

In this article, first we show that the dynamic scatterometry can be used for real time process monitoring during resist trimming process for different process parameters such as chemistries and power bias, then we discuss the influence of these different parameters on the measurement, more results at different experimental conditions, will be represented, with a comparison between dynamics scatterometry profile shape (CD, height) and 3D AFM measurements made in the same condition.

[1] S. Soulan, M. Besacier, P. Schiavone; Proceedings of the SPIE conference on Modeling Aspects in Optical Metrology, vol. 6617, 2007

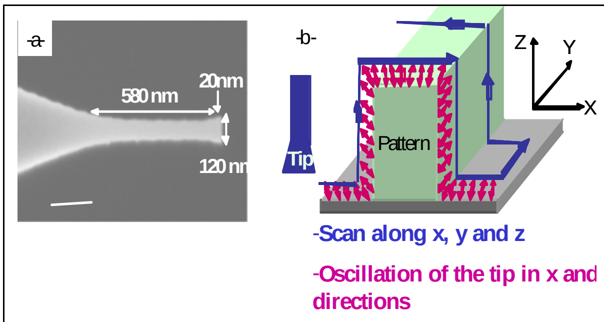


Figure 1. *3D-AFM principle*

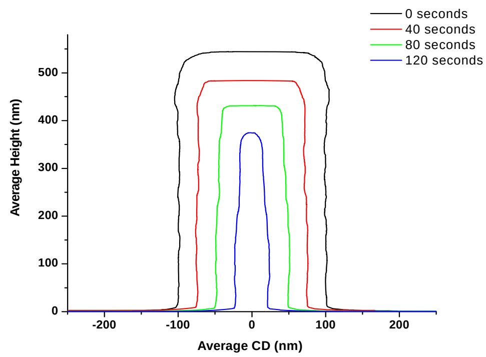
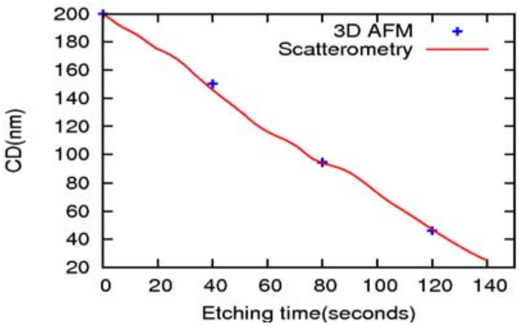
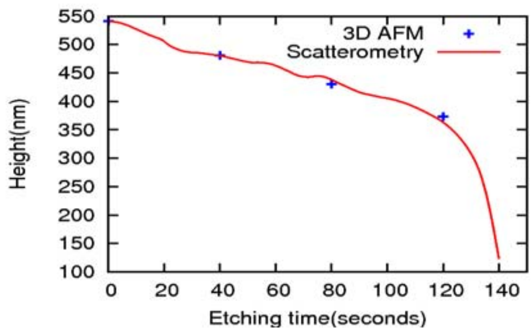


Figure 2. *AFM section image of the 250nm features of 248 nm resist at different etching times*



(a)



(b)

Figure 3: *Real time measurement results. (a): CD, (b): height of the resist feature over the processing time in HBr/O_2 plasma. 3D-AFM data are shown for reference*