Process Start-Up & Optimization …

… Parameter Studies for new Processes/Resists in Lithography

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This document wants to simplify the introduction of a new resist or a new process with an existing resist. The first page gives a short overview how the most important process parameter impact on the result, the second page can be used to log the results of the performed rest runs.

n Spin Profile and Resist Film Thickness

Generally, the last two digits of AZ® resists (e.g. AZ® 6632) indicate the (softbaked) film thickness after spin-coating at 4.000 rpm (for some resists, the value holds for 3.000 U/min!) in 100 nm units (in this example 3.2 µm). However, the equipment (spincoater set-up, gyrset), the environment (temperature, atmospheric solvent saturation), the spin parameters (ramps, time), and the resist handling (dispensed volume, solvent loss by evaporation before coating) impact on the attained resist film thickness. Therefore, a *spin curve* in order to attain the real spin-speed/film thickness dependency is recommended.

Hereby, all other parameters have to be kept constant. The softbake parameters should ensure almost solvent-free resist films. For this reason, we recommend a softbake at 100°C (hotplate) for 1 minute/µm of the thickest resist film from this spin series.

n Exposure Time / Dose and Development Rate

The exposure doses given in the technical data sheet are solely ‚bench marks' for a certain resist film thickness and application. Additionally, it is not always clear over which wavelength range the calibration of the exposure tool has been performed, and how this range overlaps with the photo resist spectral sensitivity.

For this reason, we recommend an exposure series to determine the dependency between exposure dose and development rate as well as the dark erosion. Hereby, all other process parameters (resist film thickness, softbake, delays, developer and its concentration and temperature) have to be kept constant. This requirement can easily be fulfilled by performing the exposure series on *one single* wafer: If no stepper is available for this purpose, alternatively a template allows shadowing defined areas on the substrates during exposure in certain time steps giving each field a certain exposure dose.

As an optimum exposure dose, we recommend the value for which the development rate saturates towards higher doses*. Adding some 20-30% exposure dose to this value makes the process more stable against variations in e.g. the light intensity or resist film thickness.

n Softbake and Development Rate / Dark Erosion

A softbake too short/too cool increases the dark erosion during development due to the high remaining solvent concentration*. A softbake too long/too hot destroys a certain amount of the photo active compound in the resist thus lowering the development rate at increased dark erosion (the unexposed photo active compound acts as inhibitor reducing the alkaline solubility!)*. In both cases, the contrast of the photo resist drops.

A good starting point for the softbake is 100°C (hotplate) for 1 minute/µm resist film thickness. A parameter study yielding the development rate and dark erosion as a function of the softbake parameters helps to optimize these parameters for an individual process. For very 'resist-profile-critical' processes, we also recommend to monitor the resist profile as a function of the softbake parameters.

n Recommended Process

The optimum process parameter set derived from these studies is often a compromise between high throughput, reproducibility, and process requirements. If changes in equipment (spincoater, exposure tool…), in the process (resist, resist film thickness), or the developer occur, the test series affected by these changes should be repeated.

n Further / detailed Literature…

We supply detailed information (e.g. process data sheet) for all process steps addressed in this document (coating, softbake, rehydration, exposure, development…). *Please contact us!*

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**** Detailed information in our brochure ‚Lithographic processes 2005' – available on request***

Parameter study for process:	**With resist:**
Performed by:	**Date:**

n Spin Profile and Resist Film Thickness *d*

Spincoater: **Ramp:** **Resist temperature (approx.):**

Softbake temperature/-time: **Resist film thickness measurement via:**

rpm							
d (µm)							

n Exposure Time / Dose and Development Rate

Resist film thickness: **Softbake temp./-time:** **Exposure tool:**

Delay softbake ... exposure: **Air humidity:** **Developer:**

Developer concentration: **Developer temperature:**

Exposure time (s)									
Exposure dose (mJ/cm^2)									
Developm. rate (µm/min)									

n Softbake and Development Rate / Dark Erosion

Resist film thickness: **Softbake temp./-time** **Delay softbake ... exposure:**

Air humidity: **Exposure time/dose:** **Developer(-conc.):**

Developer temperature: **Development rate/dark erosion measurement via:**

Softbake time (s)									
Development rate (µm/min)									
Dark erosion (nm/min)									

n Recommended Process

Substrate pre-treatment:	**Cleaning:**	
	Adhesion promotion/promoter:	
Coating	**Ramp (+):**	**rpm/s**
	rpm:	**rpm**
	rpm (2nd step on demand):	**rpm**
	Ramp (-):	**rpm /s**
Delay	**(For resist smoothing for thick films):**	**minutes at room temperature**
Softbake	**Hotplate/oven:**	
	Temperature:	**°C**
	Time:	**minutes**
Delay	**(Rehydration of thick films):**	**minutes at room temperature**
Exposure	**Time/dose:**	**seconds = mJ/cm^2**
Development	**Developer:**	
	Developer concentration:	
	Total development time:	**seconds**

n Further Questions? Interested in more / detailed technical information?

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