Hydrocarbonaceous contamination growth induced by resists outgassing under e-beam radiation

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The emerging massively parallel electron beam direct write represents an alternative to address high-resolution and high-throughput lithography solution for advanced CMOS nodes. However, the hydrocarbonaceous contamination of the optics projection systems induced by resist outgassing during exposure is a potential critical issue, much more than in classical electronic lithography, as the outgassing level is much higher. It is thus crucial to study the resists' outgassing and the associated contamination growth mechanisms, to assess resist platform, and define realistic specification in order to limit their impact on the exposure systems.

The experimental setup detailed in Fig. 1 has been specially designed at Leti to perform electron bombardment of e-beam resist coated 100 mm silicon wafers. Two configurations are available. In outgassing measurement mode, induced outgassing is monitored with a Quadrupole Mass Spectrometer. In contamination mode, the wafer is exposed through silicon micro-machined membrane (called mimic) that simulates the projection optics system of the multi-ebeam exposure tool. In this case, the wafer stage allows suitable displacements of wafers to expose the resists to the targeted dose, thus inducing hydrocarbonaceous contamination grows on mimic edges.

Outgassing rates of resists under electronic radiation has already been studied[1]. The contamination of the mimic induced by outgassed compounds during exposure has been characterized using techniques such as Scanning Electron Microscopy and X-ray photoelectron spectrometry. This paper will report on the kinetic of the contamination growth on the mimic (see Fig. 2) depending on resist formulations with the potential presence of top-coat designed to prevent outgassing, current density during exposure and contaminants partial pressure surrounding the mimic. It will also detail the correlation between outgassing rate and species and the induced contamination on the mimic.

The research leading to these results has been performed in the frame of the industrial collaborative consortium IMAGINE.

[1] A.-P. Mebiene-Engohang et al., "Resist outgassing assessment for multi electron beams lithography," Microelectron. Eng., Nov. 2013.

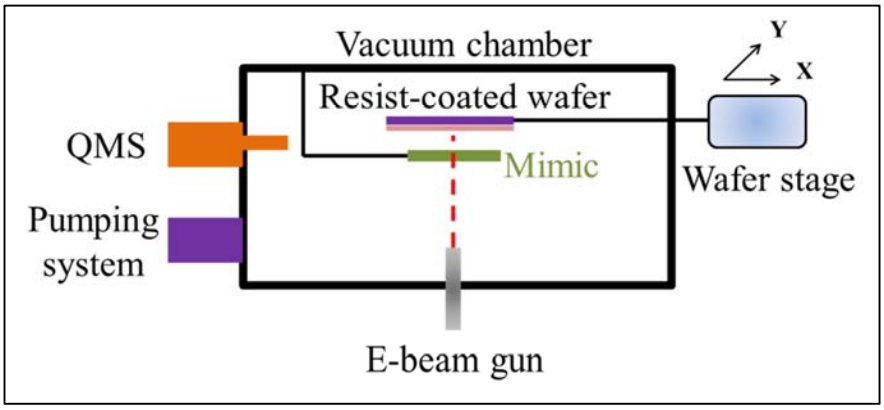

Figure 1: Schematic of Leti's 5keV outgassing test tool.

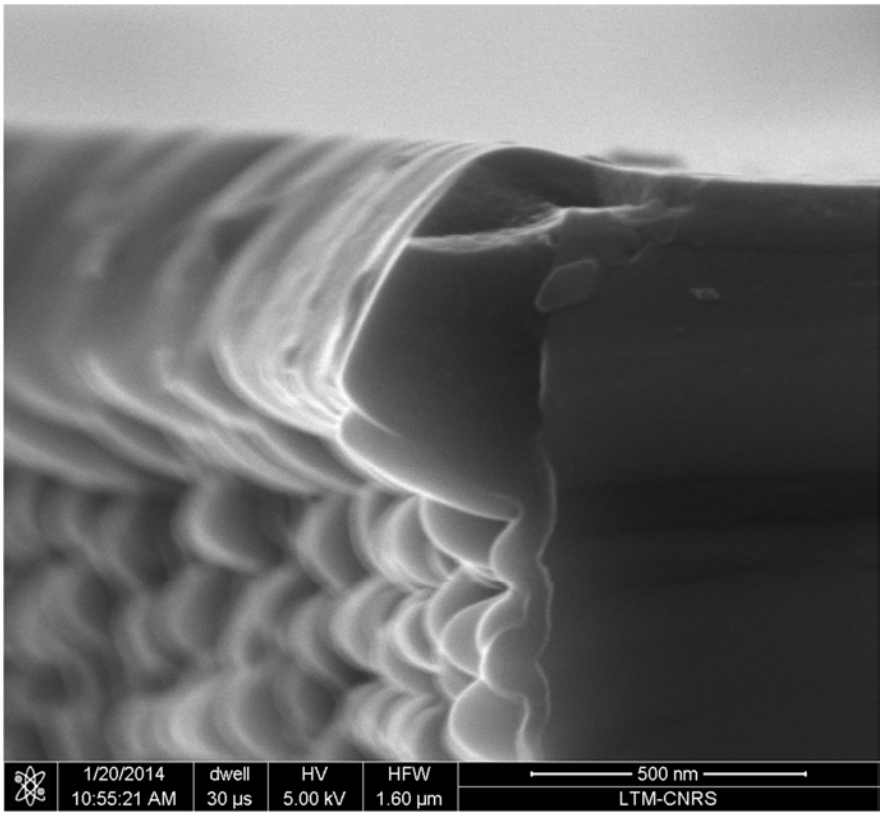

Figure 2: Contamination growth on the mimic: This SEM picture shows the edge of a micro-machined silicon 16mm diameter/100µm thick hole, along the cleavage plane. On top of the silicon, one can see the darker carbonaceous contamination layer.