Focused Electron Beam Induced Deposition assisted by molecular oxygen: growth dynamics.

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The assistance of Focused Electron Beam Induced Deposition (FEBID) processes by an additional oxidizing gas allows for the production of high quality, pure and uncontaminated transparent oxides [1]. The gas supply system in our deposition equipment was modified in order to allow for the controlled and simultaneous injection of two different gases during FEBID processes.

Series of Si containing 40x40 um^2 square shape deposits obtained from the decomposition of tetramethoxysilane $Si(OCH_3)_4$ and additional oxygen fluxes were produced and their thickness measured. The evolution of the average growth rate is presented. The average growth rate of the structures increases from 0.25 to 0.9 nm/s for $[O_2]$ / [TMOS] = 0 and $[O_2]$ / [TMOS] = 0.6 respectively. Above $[O_2]$ / [TMOS] = 0.6, the growth rate saturates. This evolution is discussed in terms of the different fluxes present during the deposition. And the trasnistion from oxygen limited to electron limited regimes

The role of back scattered and secondary electrons were decoupled. Using a free standing membrane on a bulk silicon sample, deposits were produced half on the electron transparent substrate, and half on the electron opaque substrate (see figure 1). The thickness deposited on the membrane was only 75% lower than the thickness deposited on the opaque substrate. This indicates that oxygen assisted FEBID is mainly driven by primary and secondary electrons. The importance of secondary electrons was also demonstrated by showing the influence of the acceleration voltage on the growth rate, which increased with decreasing acceleration voltage.

We demonstrate that oxygen assisted FEBID is mainly an electron initiated oxidation, influenced mainly by the flux of secondary electrons. A fundamental detailed study will be presented.

[1] Perentes A et al. Accepted for publication in CVD

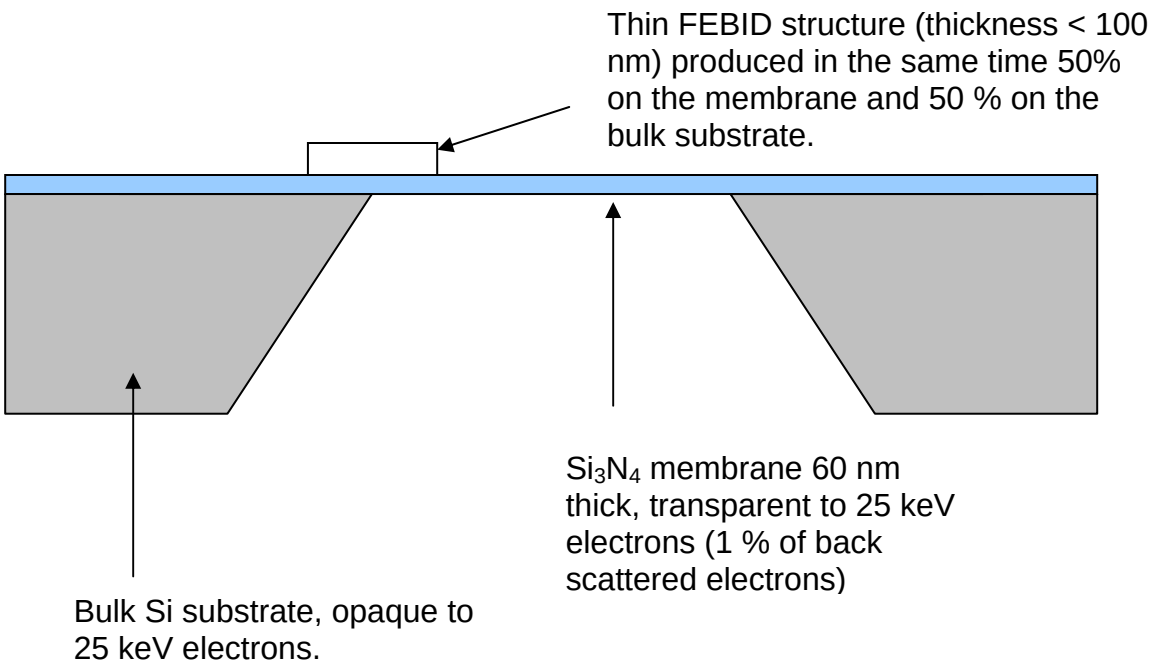

Figure 1: Sample produced (side cut) in order to investigate the roles of the backscattered electrons during oxygen assisted FEBID.