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Fabrication of Deep Oxide Gratings by Electron-Bean Lithography and M0RI Reactive Ion Etching

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Silica on silicon planar optical circuits can be fabricated at lower cost than III-V devices. This is mainly due to the lower substrate cost, larger wafer size & the relatively mature fabrication technology. However, due to the relatively low refractive index of silica, compared to III-V materials, the optical structures are typically required to be much deeper. This presents manufacturers with significant new challenges.

In this work we demonstrate processes capable of defining 0.25 µm trenches on a 0.5 µm pitch with 20:1 aspect ratio. Such structures can be used as passive components in a variety of advanced optical applications.

A pre-requisite for etching deep structures into silica is the definition of a thick mask with fine feature sizes. We describe the use of electron beam lithography for this purpose where the resulting electron beam resist has a vertical wall profile at >7:1 aspect ratio.

After mask definition, pattern transfer to the oxide is carried out in a M=0 helicon plasma reactive ion system (M0RI).[1] The process uses C4F8/CO/O2/Ar to achieve a high selectivity to the resist with the capability of etching high aspect ratio features. Optical emission spectroscopy (OES) is used to study atomic and molecular emission lines as a function of process parameters. OES data is used for understanding and optimizing the etch process.

A combination of electron beam lithography and M0RI reactive ion etching is shown to be capable of fabricating the challenging structures that are required for advanced planar lightwave circuits.

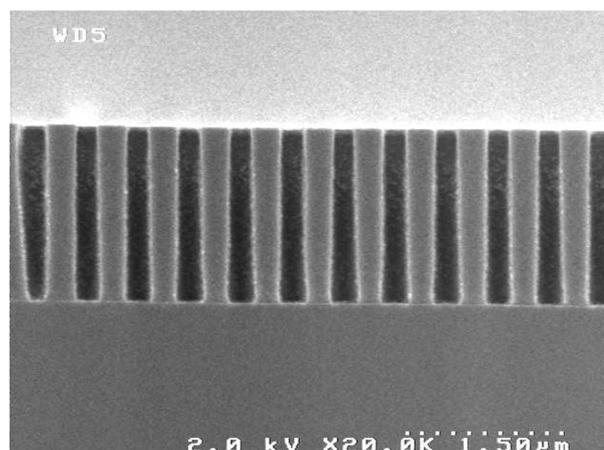

Figure 1. 1.8 µm resist with 0.25 µm Gratings defined by electron beam lithography.

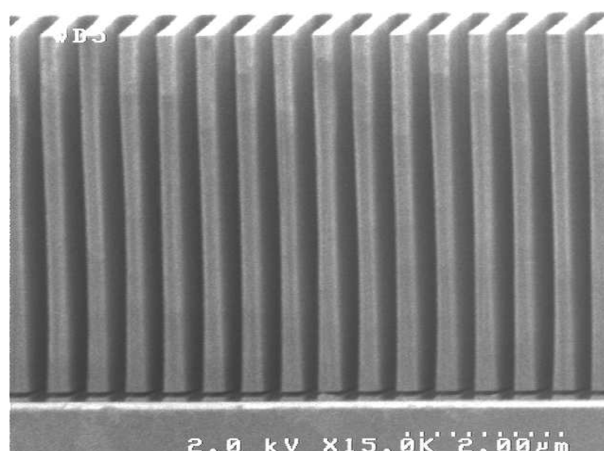

Figure 2. Etched oxide gratings with 0.25 µm wide and 5 µm deep features.

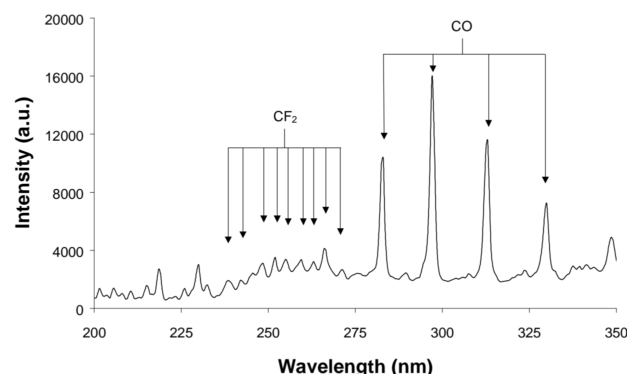

Figure 3. Optical emission spectrum showing CF_2 and CO emission lines.

[1] Y.P. Song, A. Watson, D.J. Thomas, K. Powell, H.E. Raske, W.D. Domke, M. Sebald, ECS Proc. V. 99-30, p226, 2000