PO1022

Numerically controlled local plasma jet oxidation of silicon

Thomas Arnold[1], Hendrik Paetzelt[2], Georg Böhm[2]

[1]Leibniz-Institut für Oberflächenmodifizi, Leipzig, Germany [2]Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany

thomas.arnold@iom-leipzig.de

Surface machining with nanometre accuracy of optical materials such as fused silica, SiC, ULE and silicon is still a challenging task. Especially, the local shape modification with tool diameters in the range of a few millimetre to sub millimetre, in combination with computer controlled surface scanning machines is investigated.Numerically controlled local plasma jet oxidation method comprises two processing steps to achieve a material removal. A silicon oxide layer is generated on the silicon surface by oxygen radicals provided by the plasma jet, which is then removed by HF wet etching. The main advantages of this method compared to ion beam figuring and chemical plasma jet machining can be summarized as follows: Firstly, the silicon surface is protected from material contaminations during the process, since the new surface occurring after wet etching is the former interface between the newly generated silicon oxide and the silicon base material. Secondly, the employment of fluorine containing precursor gases like tetrafluoromethane (CF_4) or sulfurhexafluoride (SF_6) can be avoided. These gases are normally used in plasma dry etching methods possibly leading to SiO_xF_y residual layers. The plasma jet presented here uses argon and oxygen as gas supply, which are much easier to handle and even more cost efficient. Removing the generated silicon oxide film with a wet chemical etching methods like HF treatment is a commonly used and well established method.All oxidation experiments have been made on standard polished silicon wafers with an orientation of (100) and a thickness of 525 µm. The oxide-layer thickness was measured using optical thin film profiler. The optical constant index of refraction n was determined using spectroscopic ellipsometry to be 1.446, which is near the value of thermal oxidized SiO_2 (n = 1.4571). The plasma jet produces a near Gaussian shaped oxidized profile with a size of 1.1 mm FWHM. The nearly linear relationship between plasma dwell time on the Si surface and the oxide thickness allows the computer controlled surface modification and machining using local plasma jet oxidation of silicon as a high accuracy surface error correction method.

Keywords
atmospheric plasma jet
surface figuring
local oxidation