Topic number: 4.

THE INFLUENCE OF THE TEMPERATURE ON THE ETCHING RATE OF SILICON FOR DEVICE FABRICATION IN NANOTECHNOLOGIES

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Etch process remains one of the crucial steps for removing layers from the surface of a wafer during manufacturing [1, 2]. In order to generate a functional MEMS structure on a substrate, it is necessary to etch the thin films previously deposited and/or the substrate itself. For that purpose, two classes of etching processes can be applied. During the so called wet etching the material is dissolved when immersed in a chemical solution, while dry etching includes sputtering of the material by using reactive ions or a vapor phase etchant. Chemical etching process is often applied to machine geometrically complex parts from thin and flat of any material. It is also used to reduce weight of the workpiece materials.

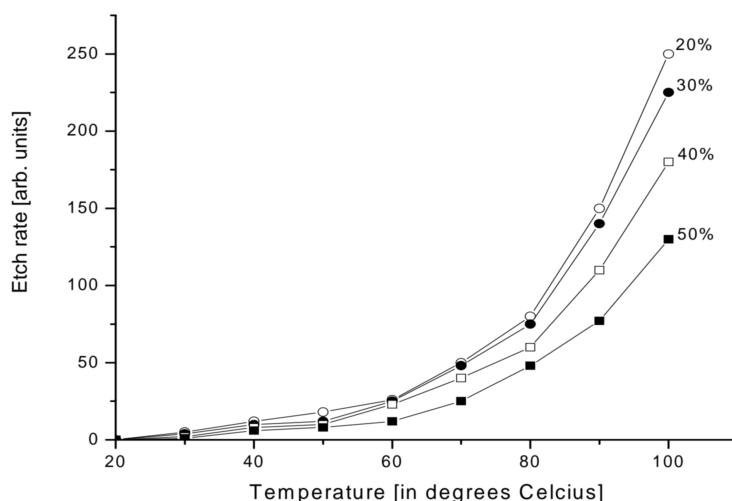

Fig. 1: The temperature dependence of the etch rate of silicon <100> for carious concentration of the KOH solution from 20% to 50% (simulation conditions are similar to those taken from [10]).

Currently, most etch rate end point determination techniques depend on indirect measurement and estimation techniques [3, 4]. Some etch monitoring techniques have relied on external measurements of film thickness followed by etch rate estimation and an extrapolated etch end point prediction [8, 9]. However, etch rates may vary due to batch-to-batch differences in the chemical and physical characteristics of the film or the etchant. Recently, simulation techniques have evolved into very effective tools that complement laboratory experiments and analytic models [5, 6]. Simulation codes have displayed a high level of sophistication and are routinely used in semiconductor industry for predicting various characteristics such as etch rate.

In this paper we discuss the application of the level set method for the modelling of the three dimensional (3D) etching profile evolution during anisotropic wet etching of silicon with KOH etchant [7]. Simulation results were achieved by using our simulation package (well documented in previous publications [8, 9]) based on the level set method for the 3D simulation of the etching profile.

Figures 1 and 2 show the etch rates depending on temperature (in degrees Celcius) for various solution concentrations (from 20% to 50 %) in the case of KOH etching of silicon <100> and <110> . It was found that solutions less than 30% KOH yield rough etching, while addition of isopropyl alcohol leads to decreasing of the etch rate by approximately 20%.

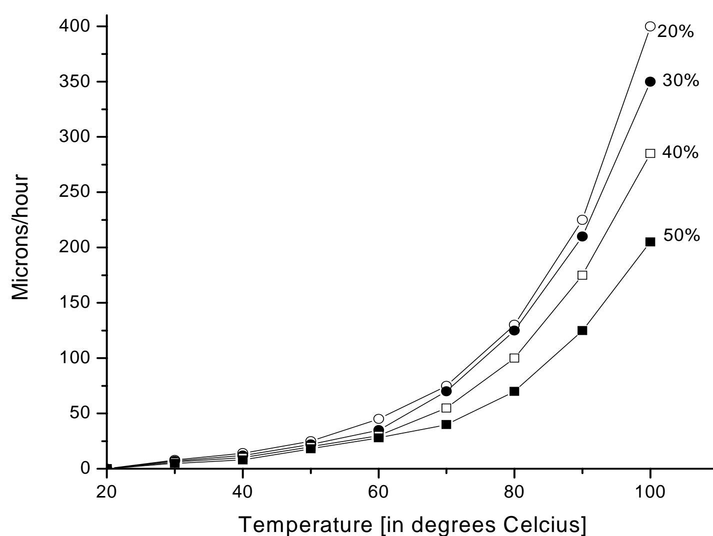

Figure 2. The etch rate of silicon <110> versus the temperature (expressed in ^{o} C) depending on concentration of the KOH solution (based on the conditions from [10]).

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