

## Corrosion of Protective Layers on Strained Silicon Surfaces in Alkaline Solutions

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For micromachined silicon sensors and actuators, certain applications exist which require the protection of the silicon surface against corrosive liquids. In this paper we present a study of the etching characteristics of several thin films which are believed to be useful for that purpose: SiO<sub>2</sub>, prepared by thermal oxidation of silicon, and several different silicon nitrides deposited by PECVD or LPCVD. Etching was performed in KOH solutions with pH values from 9 to 14 and in carbonate buffer solutions with pH values from 9 to 11 at temperatures between 50°C and 90°C. From the observed dependences some conclusions concerning the etching mechanism of the different films can be drawn. A new mechanism for the etching of Si<sub>x</sub>N<sub>y</sub> is proposed. To investigate whether or not the strain which is introduced into protective films on the moving parts of silicon-micromachined devices such as membrane pressure sensors or membrane actuators and valves in micropumps during operation affects the corrosion rate of the films, we have also performed etching experiments on the above-mentioned films at different strain levels. The strain was introduced by applying either a vacuum or pressure on micromachined silicon membranes covered with protective film. Some exceptional results were found: the etch rate increased for tensile and decreased for compressive parts of the membrane. Possible explanations for this behavior are discussed. From finite-element calculations of mass transport processes in the etchant, it is concluded that the effects are not caused by strain differences, but mainly by limited diffusion of either the active etching species or reaction products. The implications of such effects for practical applications are discussed. Some experiments on PECVD diamondlike carbon films were performed. These films exhibit an excellent resistance against corrosion, while the etch rates of the other investigated films are too high to be used in applications which require a lifetime of several years.