New Types of MEMS Structures Using CMOS Compatible Anisotropic Etchants

Prem Pal, Kazuo Sato, Miguel A. Gosalvez, Mitsuhiro Shikida*

Department of Micro-Nanosystem Engineering, Nagoya University, Nagoya 464-8603, Japan

*Laboratory of Physics, Helsinki University of Technology, PO Box 1100, 02015 HUT, Finland

Email: prem@kaz.mech.nagoya-u.ac.jp

Abstract

In this work, we have developed new types of MEMS structures using CMOS compatible etchants in (100)-silicon wafers. CMOS compatible etchants are comprised tetramethyl ammonium hydroxide (TMAH) solution with and without non-ionic surfactant NC-200 containing 100% polyoxyethylene-alkyl-phenyl-ether. Complete research includes the study of etching characteristics such as etch rates, surface morphology, undercutting at rounded concave and sharp convex corners in pure and surfactant added TMAH, and consequently the fabrication of different kinds of microstructures. The effect of concentration and etching temperature is studied using 10, 20 and 25 wt% TMAH solutions at 60, 70 and 80 ˚C. When NC-200 at 0.1% of the total volume of the etchant is used, the undercutting ratio at both rounded concave and sharp convex corners is beneficially reduced as the etchant concentration is increased while, simultaneously, the etch rate increases. This is the opposite trend to the etch characteristics of pure TMAH. In addition, the rough etched surface morphology at low concentration is also improved by using NC-200. By analyzing the etching characteristics of TMAH with and without NC-200, the etching solution which provides reasonable etch rate, smooth etched surface finish and minimum undercutting at both rounded and sharp convex corners was chosen for the fabrication of MEMS structures such as microstructures with rounded concave and convex corners, grooves for chip isolation and mesa structures with bent v-grooves and 45º mirror. A round-shaped mask pattern is designed to form the rounded etched concave corners, and for the convex corners, various kinds of compensating mask pattern were studied. The size of the compensating mask pattern has been drastically reduced due to the large reduction in undercutting, resulting in a space-efficient compensation design.