

MEMS Release

Jerzy Ruzyllo, Penn State University

The progress in manufacturing processes of silicon electronic devices and integrated circuits enables today's semiconductor technology to fabricate a vast array of Micro-Electro Mechanical Systems (MEMS) using silicon. One important step in the MEMS fabrication sequence is a release process which releases moving parts of a MEMS device, e.g. cantilever beams in Fig. 1a.

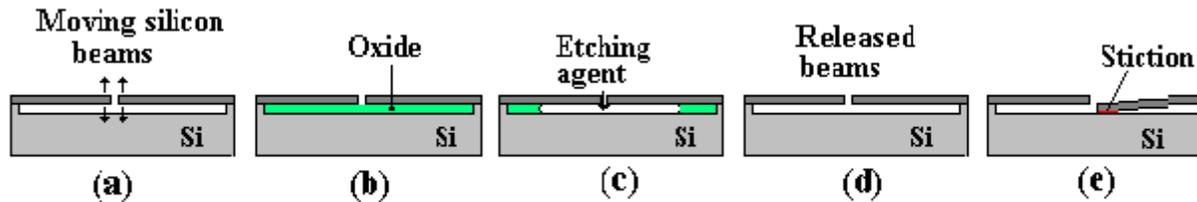


Fig. 1

The MEMS release process typically comes down to etching of a sacrificial oxide upon which future moving parts are initially formed (Fig. 1b). A provision is being made for the etching agent to access a buried oxide (Fig. 1b) so that etching reactants may penetrate to the etched oxide while at the same time products of the etch reaction are being removed from the etched region (Fig. 1c). Upon completion of the sacrificial oxide etch, beams are released (Fig. 1d), and free to move as shown in Fig. 1a. The process is very complex when the sacrificial oxide must be etched in the very narrow, long channels. The main challenge is to prevent stiction between parts to be released and the substrate (Fig. 1e) caused by surface tension and/or incomplete removal of etching agents/products from the etched region. Such stiction renders the MEMS device nonfunctional, and hence, must be prevented.

Both wet etching and gas-phase etching methods were explored in the release of fine geometrical features in MEMS devices. The main drawback of wet etching technique is an increased chance for the stiction to occur and possible hazards to very fragile features of MEMS devices during wet etching, rinsing, and drying operations. Regarding dry etching techniques, whether in RIE (Reactive Ion Etching) or plasma mode, the challenge is to assure adequate isotropy and selectivity between sacrificial SiO_2 and Si_3N_4 that is often protecting the MEMS structure, as well as to prevent excessive damage to the Si surface during etching.

An alternative solution to the MEMS release challenges is a gas-phase chemical, isotropic etching process using anhydrous HF (AHF) vapor combined with an alcoholic solvent such as methanol. This process was explored in MEMS fabrication showing effective, stiction-free release of various structures. The process is supported by commercial, multi-wafer, temperature controlled, reduced pressure tools specifically designed to implement AHF/alcoholic solvent etch process. See www.primaxxinc.com for more info.