# Fabrication and Simulation of a Multi-Axis Capacitive Micro Accelerometer Using UV-LIGA process

Jong-Zen Huang, Huang-Shao Ko and Chen-Pin Lee
Department of Mechanical Engineering
Southern Taiwan University of Technology
Tainan 710, TAIWAN
Phone: +886-6-2533131 ext. 3532
Fax: +886-6-2425092
E-mail: jzhuang@mail.stut.edu.tw

**Abstract**

This work focuses on the processes of fabrication and simulation for a multi-axis capacitive micro accelerometer. By intensive cross checks among two MEMS-related application software and one Finite Element Analysis software, improvements can be made both in shortening the process of building model of the micro accelerometer and in speeding up its design verification among different software. Meanwhile the optimization for the structure design can be also realized (refer to Fig. 1). As for the fabrication of the micro accelerometer, a CMOS compatible UV-LIGA process [1], together with the technique of sacrificial layer, is proposed (see Fig. 2). Instead of conventional metallic material [2], the sacrificial layer in this study is made of photoresists (S1818, AZ5214) so that the cost of metal decomposition can be saved and the potential damage to the structural layer caused by metal etchant can also be prevented. The structural layer itself is defined by the micro mold, which consists of photoresist SU-8. Fig. 3 and 4 show the SEM photos of the micro mold. As indicated in Fig. 5, it is crucial to control the temperature and time when it comes to the soft baking process for thick photoresists. To removal SU-8 photoresist, oxygen plasma etching, that was examined to be relatively effective [3], is employed. The etching rate is set about 4000 Å /min under 40 sccm $O_2$ plasma at 300 mTorr and 250 Watt RF power. The principal structural layer of the micro accelerometer is fabricated by electrolyte whose composition is $Ni(SO_3NH_2)_2$:$NiCl_2$:$H_3BO_3$:$NiCO_3$=350:5:30:3. The pH value of the electrolyte solution was adjusted to a value at 4. The bath of electroplating was heated and retained at temperature of 50□ and the plating current is fixed at 3 A/dm$^2$. The resulted electroplating of Ni with speed of 0.4μm/min successfully constitutes a structure layer with high aspect ratio.

**Reference:**

[1] Sadler, D.J.; Gupta, S.; Ahn, C.H. ”Micromachined spiral inductors using UV-LIGA techniques” Magnetics, IEEE Transactions on , Volume: 37 Issue: 4 Part: 1, pp.2897~2899, 2001

[2] David Westberg, Oliver Paul, Gert I Andersson and Henry Baltes, “Surface micromachining by sacrificial aluminum etching”, J. Micromech. Microeng., 6, pp.376~384, 1996

[3] H.Lorenz, M. Despont, N Fahrni, N LaBianca, P. Renaud, and P. Vettiger, “High-aspect-ratio, ultra-thick negative tone near UV photoresist and its application for MEMS”, J. Micromech. Microeng., 7, pp.121~124, 1997

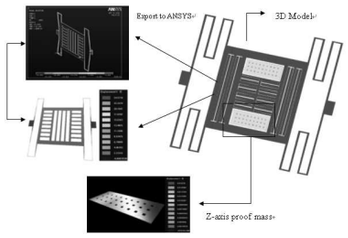


Fig.1. Software Simulation and Analysis

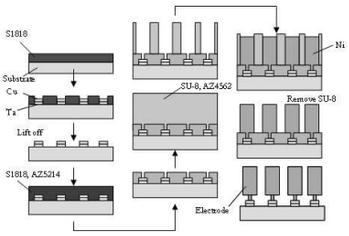


Fig.2. Fabrication steps

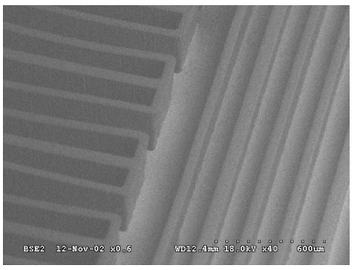


Fig.3. SEM photo of micro mold

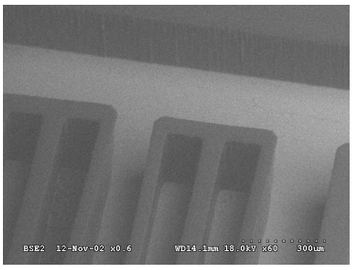


Fig.4. SEM photo of micro mold

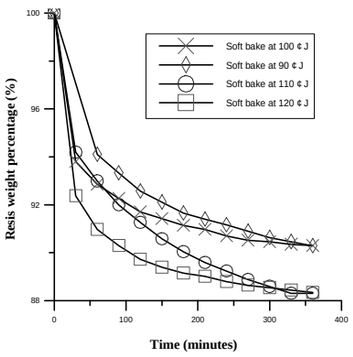


Fig.5. Soft Baking time vs. weight-percentage