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Low-cost HARMS process

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Abstract

A low-cost HARMS (High Aspect Ratio MicroSystems) process has been developed, which enables the fabrication of micromechanical parts or entire systems of metal. In comparison with the original LIGA process, this process is a truly low-cost one. Based on a state-of-the-art mask technique, UV-sensitive polymer and a self-built spray processor for resist development, structures with heights of 300 μm, lateral dimension of 30 μm, sharp sidewalls and aspect ratios up to 10 can be achieved. The developed moulds can be filled with metals (Ni, Cu) using electroforming. A proper control over some plating-bath parameters is imperative when no defects are allowed. Especially for a nickel(II)-sulfamate bath, temperature, particle filtration, periodic active carbon filtration of degenerated organics, pH measurement and monitoring of the nickel concentration are required. Monitoring the surface-active agent concentration is of great importance. Potentiometric titration using a new tenside electrode allows determination of the agent and its decomposition products. Examples of gearwheels and planar coils in photoresist and metal are given.

Keywords: LIGA technique; HARMS process; UV depth lithography; Spray development; Electroforming; Electrolyte monitoring

1. Introduction

At the Neu-Technikum Buchs (NTB) an affordable, UV depth lithographic process with subsequent electroforming has been developed. Although the quality of this process (steepness, aspect ratio) is not as high as that of the original Karlsruhe LIGA technique [1] (see Fig. 1), for a lot of sensor and actuator applications it is quite suitable. In addition to this, the occurring mask costs are two decades lower. The two processes are compared in Table 1. Since the first presentation of this process, the interest of small and medium-sized enterprises (SME) is growing continuously for various applications. Similar manufacturing procedures have been presented by Allen and Frazier [2], Lorenz et al. [3] and Gobet et al. [4].

2. Metallization sputtering

The first problem which has to be taken into account is the deposition of an appropriate arrangement of layers (metallization) for electroforming high metal structures.

2.1. Requirements for the metallization

- Good adhesion on the substrate
- Compatibility with the resist system (no copper)
- Resistant in plating bath
- No passivation prior to electroforming

This profile of requirements can be met by the subsequent set of layers.

Titanium shows good adhesion on both glass and silicon. With respect to electrical resistivity, a sputtered thickness of approximately 1000 nm is sufficient as seed layer. Since titanium tends to form its stable oxide (TiO_2) this fact has to be considered, and the exposure to oxygen has to be minimized. Therefore processing must not be interrupted.

To achieve a plated metal without any defects, the surface of the seed layer must be free of any organic residues (resist spots). To meet this demand, the substrate is subjected to a short plasma flash-strip. After this dry etch step, an organic-free clean seed layer is ready for further processing.

3. UV depth lithography

3.1. This process step brings cost savings

The potential for savings compared to the original LIGA process is based on this process stage: photolithography. The

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