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Technical note

Development of a microgripping system for handling of microcomponents

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Abstract

This paper reports the development of a semi-automatic microgripping system that consists of a microgripper and an *x*, *y*, *z* positioning system. The microgripper has two 1DOF fingers fabricated by an amorphous, soft magnetic material and is actuated electromagnetically. The microgripper is embedded in the 3DOF positioning system with the help of a stainless steel holder under an angle, which is manually adjusted, in respect to the working field. The position of the microgripper is observed optically and by three digital indicators[1] from Mitutoyo, which offer easy reading and continuous position tracking. All axes are actuated by step motors which allow precise positioning of the microparticles under manipulation. The microgripping system was tested in pick and place cases, under an optical microscope in atmospheric conditions. Optical fibres (125 μm in diameter) and bonding wires (50 μm in diameter) were handled. The temperature on the actuator, on the microgripper fingers and on the microgripper tips during manipulation was measured using K type (Ni/CrNi) thermocouples. The gripping force was evaluated as well.

Keywords: Micromanipulation; Microgripper; Microsystems

1. Introduction

In recent years there has been an increasing interest in micromanipulation technology [1–5]. The effective handling of these components is one of the most challenging tasks in the fields of handling, assembly and testing of mini/micro systems [6–7]. In this work a flexible, inexpensive, semi-automatic microgripping system was designed and developed so as to be able to carry out a wide range of applications.

2. Architecture design

The design of the microgripping system is described in this section. An electromagnetically actuated microgripper, is mounted on a stainless steel holder. The holder can be manually positioned under an angle of 0–180° in respect to the working field. In this way the lower edge of the microgripper tip is parallel to the working field. The holder is then mounted on the automatically controlled *x*, *y*, *z* positioning system. All particles to be manipulated (optical fibres and rubber particles) are placed on another mobile platform. Fig. 1a shows a photo of the developed system, Fig. 1b a photo of the microgripper and Fig. 1c a more general view of the microgripping system showing the automatically controlled *x*, *y*, *z* positioning system as well as the mobile platform on which the particles are placed. The speed of the microgripping tasks was 20 μm/s.

3. Microgripper

The fingers and the tips of the microgripper are fabricated using amorphous materials, which exhibit excellent soft magnetic and mechanical properties, such as VITROVAC 7505

[1] A digital display which allows to directly read physical values.
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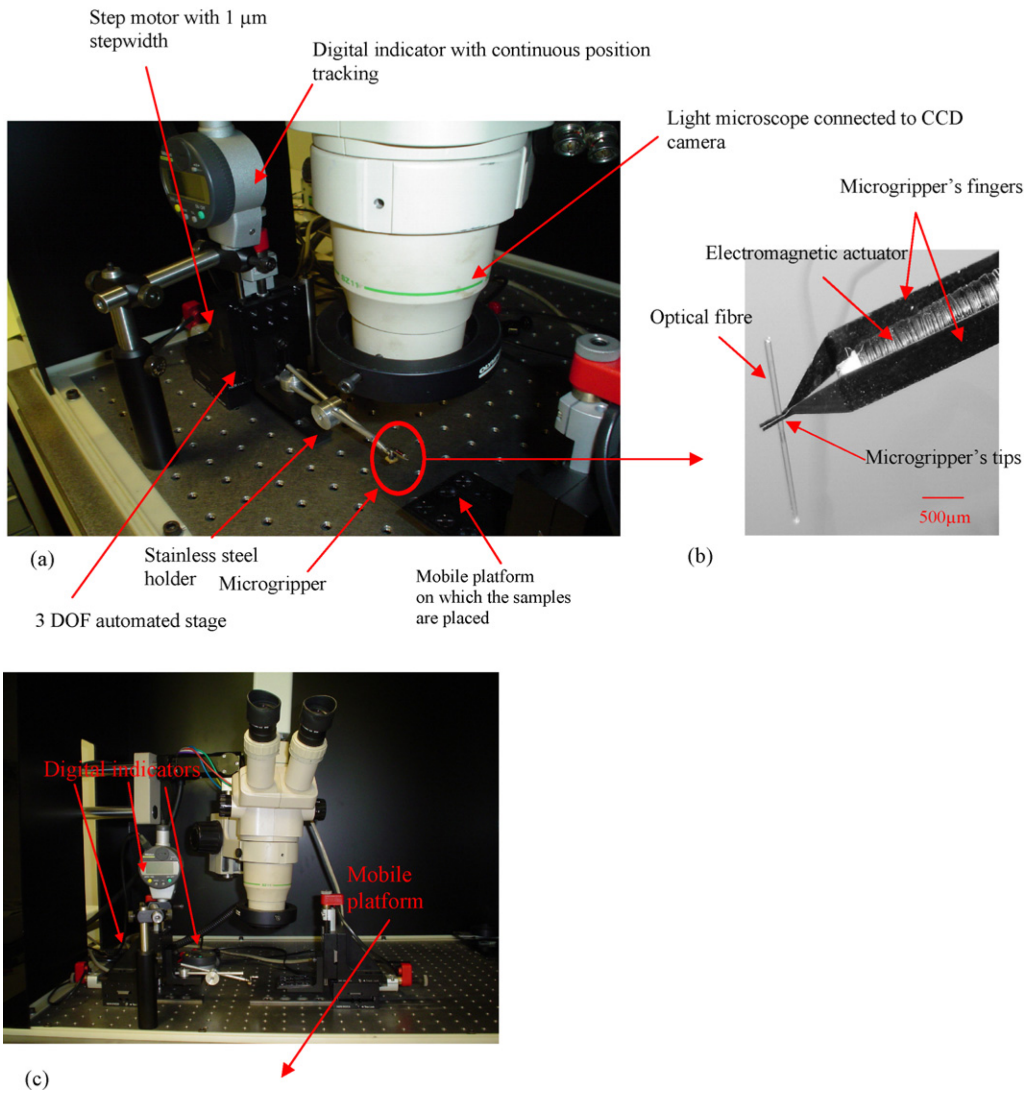

Fig. 1. (a) Photo of the microgripping system showing the 3 DOF automated stage, the 3 digital indicators, the step motor, the stainless steel holder with the microgripper attached and the additional manually mobile platform on which the samples are placed. (b) Photo of the electromagnetically actuated microgripper.

(maximum pulse permeability 4000–8000 Vs/Am) or Metglas 2714A (Co-based alloy, corrosion resistant). Best performance results were obtained with VITROVAC 7505. VITROVAC has high magnetization, high susceptibility and is thinner than Metglas. Good performance with Metglas was observed with higher applied current but it was not preferable for the described applications. The fingers and tips are produced by cold laser cutting. The shape of the end of the tips is shown in Fig. 2. Such shape helps grasping firmly one single micropart from many, even if the parts are placed very closely.

The actuator consists of a double layer coil (120 windings of wire with 70 μm diameter) wound around a highly oriented crystalline FeSi sheet. This core of the coil was cut using electro-discharge machining (EDM) technology. The fingers of the microgripper are fixed on the left and right side of the actuator by agglutination (see Fig. 3). They are symmetrically activated by the magnetic field generated by the actuator. Therefore, the opening/closing of both microgripper fingers (see Fig. 4a and b) is controlled by the applied dc current (0–600 mA). The techni-

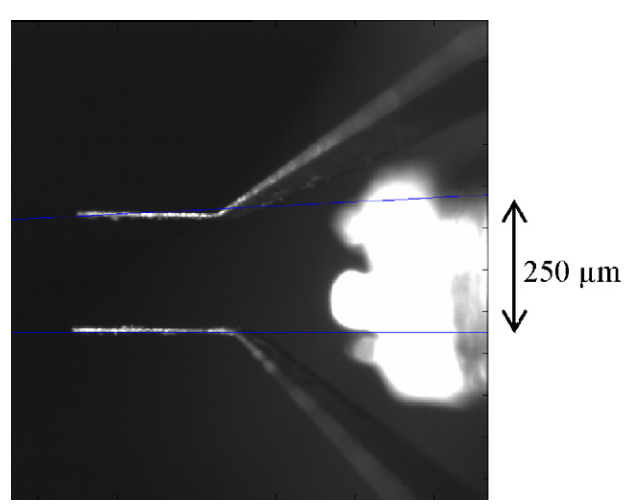

Fig. 2. Photo, taken under the microscope, of the tips of the microgripper.