MANUFACTURE OF NANOPOSITIONERS FOR SCIENTIFIC AND INDUSTRIAL APPLICATIONS

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1 Introduction

Nanostructures in diverse material systems are the focus of research in various groups around the world, as not only new properties can be revealed, but also knowledge about processes already consolidated industrially can be revisited. Phenomena related to the dimensionality of matter are extremely relevant whether in industrial catalysts such as the physicochemical mechanisms of reaction of molecules on surfaces or in pigments used since the middle ages in which nano particles of copper, silver and gold are responsible for the observed colors [2]. Researches involving nano materials generally seek the correlation between functional macroscopic properties with their chemical, crystalline and morphological nature. For this reason, the development and innovation in nanotechnologies are dedicated to the combination of microscopy and spectroscopy with nanometric.

The project proposes the development and manufacture of a nano positioning device for instrumentation in microscopy and spectroscopy in low temperature and ultra high vacuum conditions. The innovative potential of the device will allow the development of a high value-added nanotechnology product in an industry still incipient in Brazil. This project seeks to integrate applied science in the development of a device with great future marketing potential and basic science creating conditions for scientific discovery in nano science, through the use of this device in probe and electronic microscopes. The main focus is on the experimental work, with the development of the nanopositioner designs, the mechanical fabrication and the performance of practical tests, as well as some characterizations of the generated device.

2 Methodology

Based on studies of existing nanopositioners and adapted to the size of piezoelectric ceramic, as well as to meet the size required for applications in microscopy, it was thought an unprecedented and functional design. The positioner was then designed using the solidworks software and then started machining in the CBPF machine manufactory.

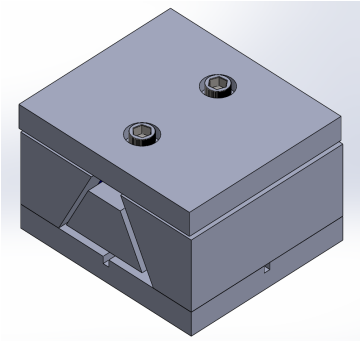

Figure 1: Isometric view of the nanopositionerr generated on solidworks.

In order to move the positioner it is necessary to use an electronic capable of generating voltage and couple the piezoelectric ceramics, which will receive the tension, contracting or expanding and thus generating the movement[3].

In addition, to couple the piezos, care must be taken with the temperature, since the glue needs to be heated but the piezos lose their properties if they are heated up to a certain temperature. Polishing will be carried out to improve the rough shape after machining and also facilitate the operation. A software of the electronic was installed, which allows controlling the movements of the positioner through a computer.

3 Results

The positioner has been successfully produced and is in the final stage of assembly, where the polishing was done to facilitate the movement. Afterwards, the piezos will be coupled with epoxy glue and connected in the electronics to move. A calibration will be done using an optical microscope.

The piezos need to be ”stacked” to perform the movement in the desired directions, for that an electrode is also used.

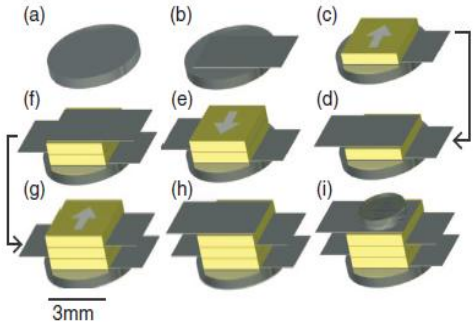

Figure 2: Example of building a piezoelectric stack. In (a) the base, in (b) an electrode is placed on the base with epoxy. In (c) the first piezo is inserted with the desired polarity. From (d) to (h) alternating electrodes and piezos are inserted. In (i) the last electrode enters and a sapphire plate is coupled [1]

After being completely complete, the positioner will be tested in STM (Scanning Tunneling Microscope) and its behavior will be evaluated in vacuum and at low temperatures.

4 Conclusions

In the first step, a design capable of moving samples in one dimension or up to 3 dimensions(when two or more positioners are coupled), was generated. In addition, more possibilities were opened:

- The main positioner is expected to be finalized in march 2018;
- Two prototype designs of other designs are ready and being evaluated;
- The goal would be to reduce the overall weight and measures of the device, when operated in more dimensions;
- Possibility of operating in all dimensions without the need of coupling;

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