Microgriper for Biological Testing

Ivan Javier Muñoz Cano, Karina Hurtado, Jorge Rosales, Angel Varela,
Juan Borunda, Diana Sanchez, Eric Montañez, Jose Mireles Jr.
Universidad Autónoma de Ciudad Juárez, CHIH., México
Ivan.munoz@uacj.mx

Centro de Investigación en Ciencia y Tecnología Aplicada

Abstract

This work presents an alternative for mechanical viscoelastic behavior testing for diagnosis and pathological mechanical changes in cells with 100um + diameter size [1]. The design uses SUMMIT- V process and consists of three main parts: a) a set of thermal actuators for driving b) a pair of mechanical transmission gear and c) two final effectors consisting on a set of tweezers used as clamps to hold the cell and a moving tip needle that is used to penetrate the cell to sense or apply electrical signals to the cell[2]. The clamps and tip needle are moved through the gear set to increase strength[3]. The translation of electrical to mechanical power is controlled by varying the voltage – current drop in thermal actuators. We will provide details of the design and resulting FEA and simulations [4].The device was sent for fabrication to Sandia National Laboratories, NM, due that all DRC was approved.

INTRODUCCION

Field of micromechanical devices is extremely broad. It encompasses all of the traditional science and engineering disciplines, only in a smaller scale. The utility of this proposed design can have numerous applications. The main idea comes from the necessity to detected diseases with more facility. Cells contains a lot of information about the body and depending of certain states of it we can diagnostic diseases or prevent them. We have interest in microtechnology for the development of gripers or tweezers for biological testing. Through the advance of microtechnology, or the development of Micro- Electro-Mechanical Systems (MEMS), a variety of microgrippers have been developed for the manipulation of micro-structures, materials and including manipulation of biological parts and testing.

DISEÑO

The design is divided into four parts: 1) the microgrippers have an initial opening of 180 degrees and may hold cells about 150um in diameter when closed; 2) transmission system reduces the closing speed of the gripper, but increase in force thirteen times; 3) chevron actuator has a force of about 6 um, synchronized with everyone else, are the moving gears; 4) tip probe, is to conduct visco-elasticity tests, applying a force on the cell serving also as an electrode for electrical measurements (figure 1).

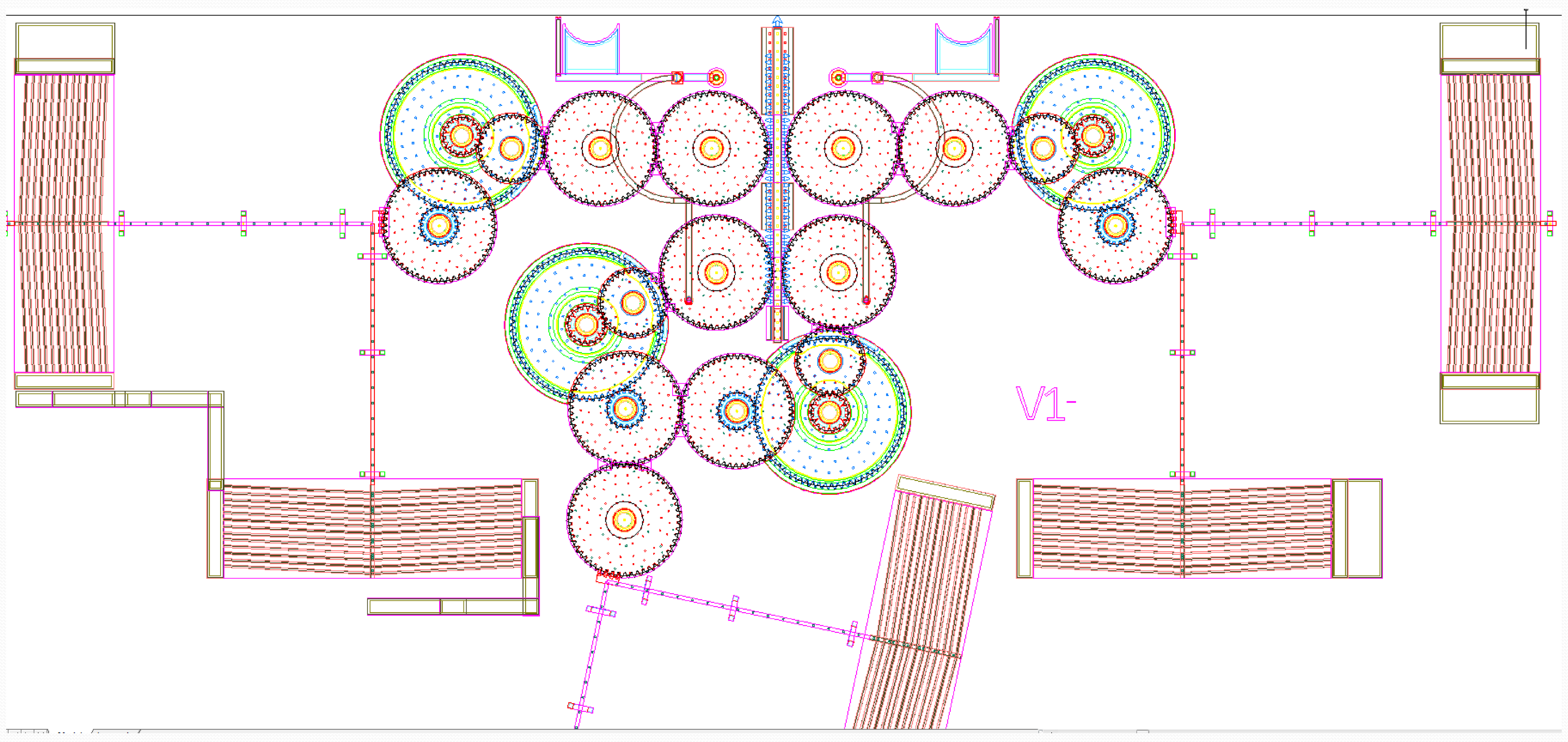

Figure 1. Microgripers full design

SIMULATIONS AND SEQUENCE

Chevron actuators are triggered with a voltage of 5V with a square wave and a frequency of 10hz, maximum temperature is 1500 K and a displacement of approximately 11.92 □ m, simulation was performed with four, eight and twelve pairs of arms, this in order to reduce computation time, and then extrapolating its displacement and force until reached 26 arms (Figure 2). Clamps are closed at a rate of 0.83RPM and a final torque 451 658 N □ once closing the pliers (Figure 3).

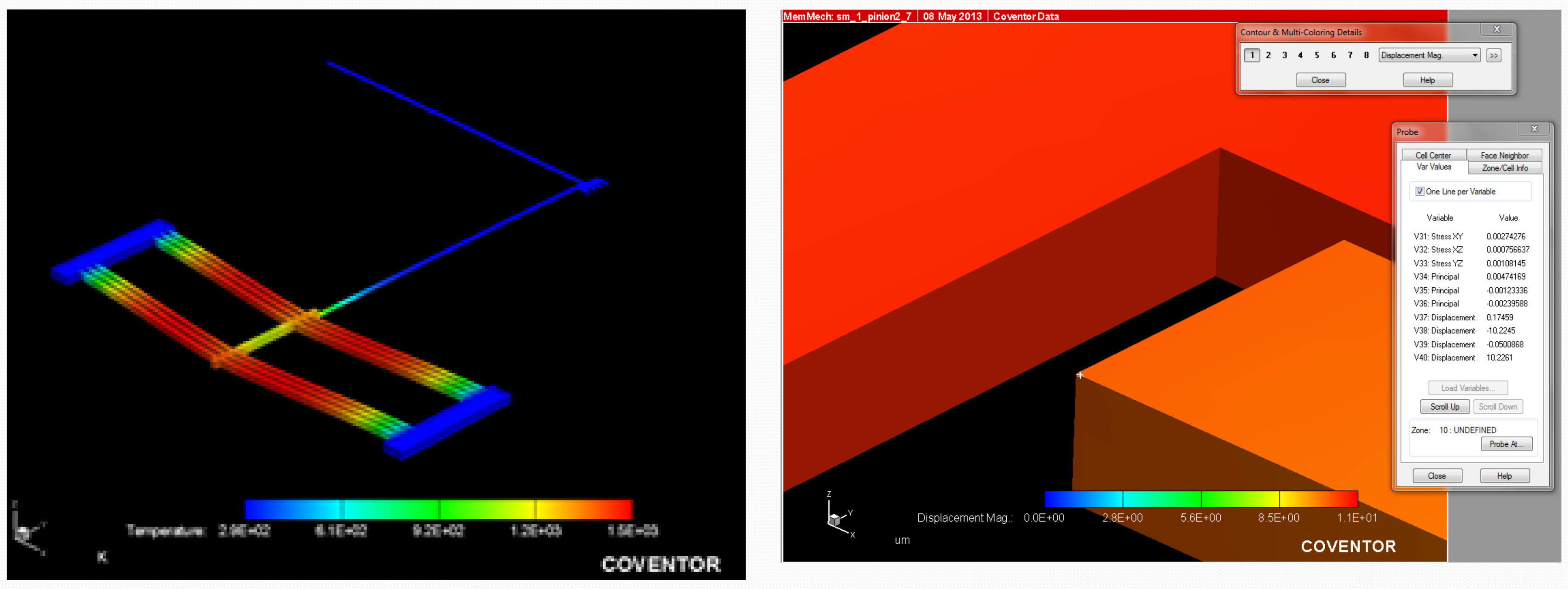

Figura 2. Maximum displacement and temperature

After closing clamp, the tip probe performs the visco-elasticity tests, tip probe also has a series of gears to reduce the speed but increase the force, with a frequency of 10Hz travel time of the 149 7.2sy □ m is a force of 430 □ N (figure 4).

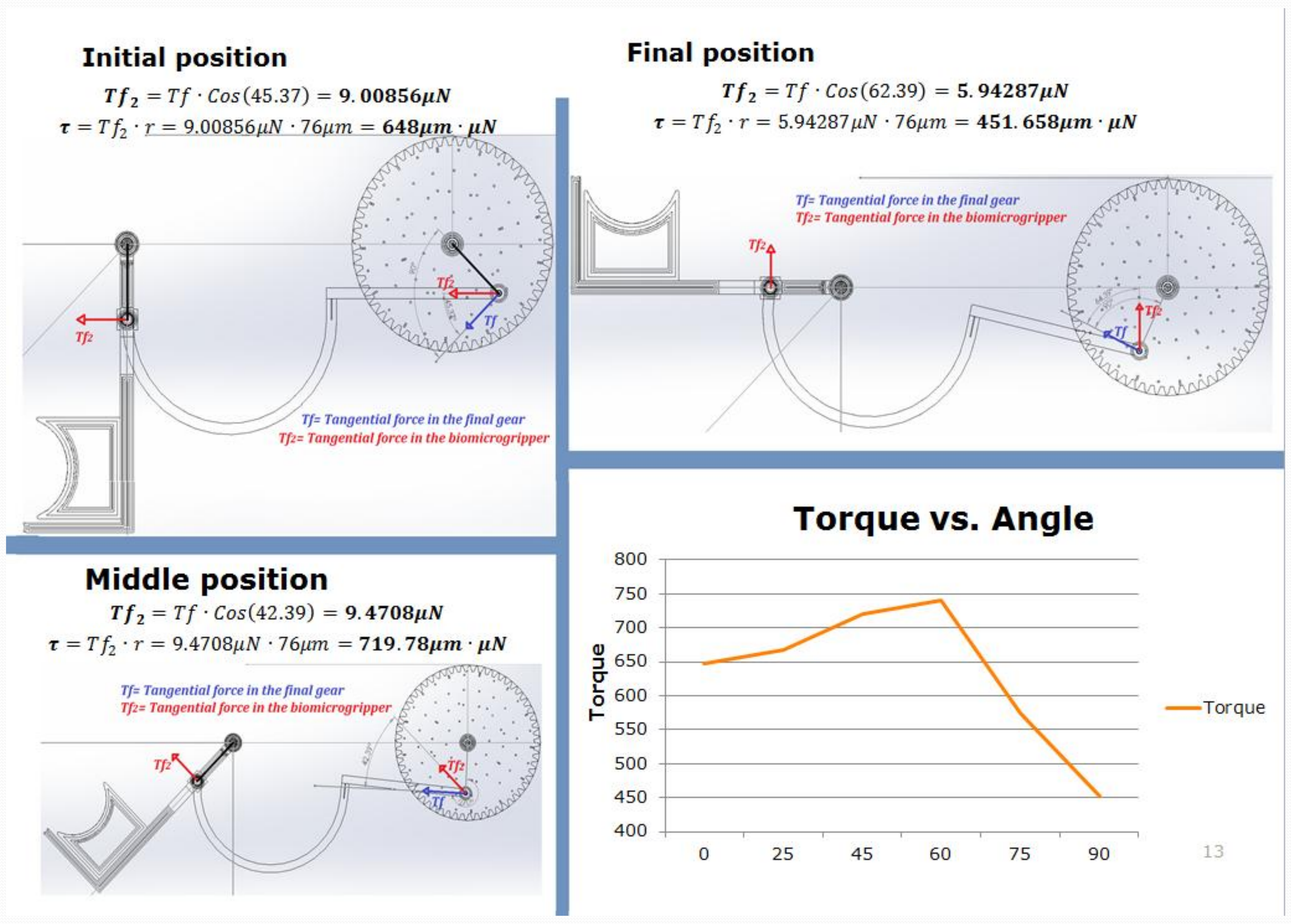

Figure 3 . Positions and clamps forces

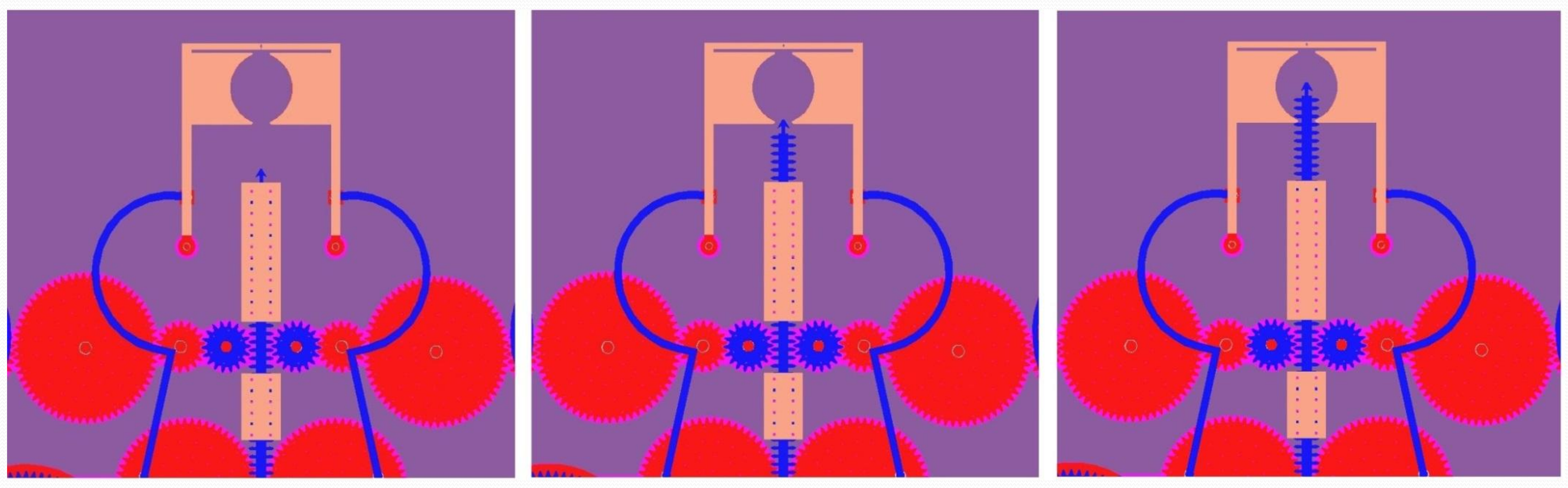

Figure 4. Tip probe positions with closed clamps

Expected Results

The expected mechanical and electrical measurements of the cells are expected to have a starting point where you compare a healthy cell to a non-healthy one, applying a tip probe forces, this will yield relevant information. According to previous references unhealthy cells have different mechanical and electrical properties compared to healthy cells. Tests will be carried out in the laboratory in a controlled environment to obtain more reliable data and analyze different cells with different pathology

It is estimated that the clamps being a piece which could open and close, it is certain that will be used multiple times.

CONCLUSIONS

As can be seen in the simulations clamps begin with a force at an angle of 90 degrees and once shut down that force drops to minimum. The aim is to hold the tweezers without pressing the cell to much and with this, the tip probe would be able to perform visco elasticity testing. This design was presented in a competition in Albuquerque and was sent to manufacture.

Reference

[1] Alperen N. Ketene, Eva M. Schmelz. “The effects of cancer progression on the viscoelasticity of ovarian cell cytoskeleton structures. Nanomedicine: Nanotechnology, Biology and Medicine” 8 (2012) 93-102

[2] A. Alogla, P. Scanlan, W. Shu and R. Reuben, "A Scalable Syringe- Actuated Microgripper for Biological Manipulation," Procedia Engineering, vol. XXVI, no. 47, p. 882 – 885, 2012

[3] B. Solano and D. David Wood, "Design and testing of a polymeric microgripper for cell manipulation," Microelectronic Engineering, no. 84, p. 1219– 1222, 2007

[4] Sang H. Lee, K.- C. Lee, Seung S. Lee and H.- S. Oh, "Fabrication of and Electrothermally Actuated Electrostatic Microgripper," in IEEE, Boston, 2003.

[5] M. Carrozza, A. Eisinberg and A. M. J, "Micromech. Microeng," no. 10, p. 271– 276, 2000.