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RESEARCH ARTICLE

LOW COAST DEVICE FOR MANUFACTURING BOROSILICATE MICROPIPETTES

***,[1]Walter Duarte de Araújo Filho and [2]Luciana Martins Pereira de Araújo**

[1]Department of Exact and Earth Sciences-Laboratory of Physics (Micro fluidic sector), State University of Bahia, Brazil

[2]CPGEI, Federal Technological University of Paraná (UTFPR), Brazil

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ABSTRACT

The manufacture of borosilicate micropipettes is a process based on the heating of a glass tube through a flame or electrical resistance associated with a longitudinal traction of the tube. The heating of the glass makes it malleable which causes it to suffer a linear deformation and consequent reduction of the cross section, allowing the production of micropipettes of internal diameters tip (ID), less than 10μm. borosilicate micropipettes are used in various applications to inject micro-fluids or substances into microstructures. They are used in experiments that involve great precision and rigor and use microscopic amounts of substances notably in Analytical Chemistry and Microbiology. In Microbiology it can be used in IVF (In Vitro Fertilization), i.e., fertilization of the ovum occurs outside the female organism. Particularly in this area, the use of these devices has a high cost due to the high degree of precision and control of the internal dimensions of the part of the micropipettes that encounters the structures, in the specific case the ovule. In this case, the end of the micro capillary (tip or needle) must have rather small dimensions of the order of micrometers. The regular cost of each of these micropipettes is in the range of US$ 25.00 to US$ 30.00, which is a factor that costs the cost of the medical procedure highlighted. Aiming to reduce the burden of this operation, a process of manufacturing borosilicate micropipettes with the above characteristics was developed, at a maximum cost of US $ 0.17, that is, almost two hundred times smaller than the initial cost of a known micropipette. In this article, we will make a brief reference of the manufacturing process and the preliminary results achieved.

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INTRODUCTION

One of the processes for manufacturing borosilicate micropipettes is based on the capillary heating through a flame associated with a longitudinal traction of the capillary tube (McAllister, Devin *et al*. 2003). The heating of the glass makes it malleable which causes it to suffer a linear deformation and consequent reduction of the cross section, allowing the manufacture of micropipettes with internal diameters of tip (ID), less than 10μ. The diameter of the micro capillary, therefore, is inversely proportional to the linear deformation of the tube (Figure 1). Micropipettes are used in various applications to inject micro-fluids or substances into microstructures. They play an important role in experiments that involve great precision and accuracy and use microscopic amounts of substances, especially in Analytical Chemistry and Microbiology (Palanker, Daniel *et al*., 1991; Kühnert, 1991; Metka *et al*., 1987, O'Brien, Marilyn *et al*., 2003; Roux *et al*., 1995). In microbiology, they can be used in IVF (In Vitro Fertilization), that is, when the fertilization of the ovum occurs outside the female organism (Figure 2). Particularly in this area, the use of these devices has a high cost due to the high degree of precision and control of the internal dimensions of the micropipettes that meet with these biostructures, in the specific case, the ovule. In this case, the tip of the micropipette should have very small dimensions, of the order of micrometers. (Dandekar *et al*., 1984; Griffiths *et al*., 2000; Yaun *et al*., 2008; Bleil and Jeffrey, 1993; Trounson, *et al*., 1981; Zegers *et al*., 2009) The regular cost of each of these micropipettes is in the range of US$ 25.00 to US$ 30.00, which is a factor that costs the cost of the medical procedure highlighted. Aiming to reduce the burden of this operation, a process of manufacturing micro capillaries with the above characteristics was developed, at a medium cost of US $ 0.17, that is, almost two hundred times smaller than the initial cost of a known micropipette. In this article, we will make a brief reference of the manufacturing process and the preliminary results achieved.

Corresponding author:* **Walter Duarte de AraújoFilho,
Department of Exact and Earth Sciences-Laboratory of Physics (Micro fluidic sector), State University of Bahia, Brazil.

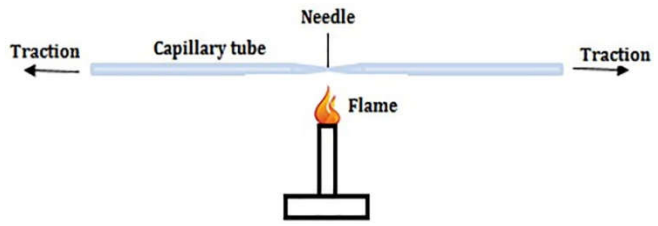

Figure 1. Process manufacturing of micro capillaries using the flame. The intern al diameter of the micro capillary decreases with increasing longitudinal traction

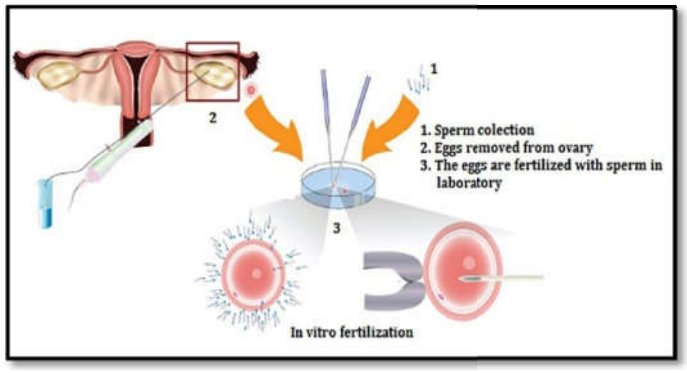

Figure 2. In the in vitro fertilization (IVF) process, micropipettes play a key role: they take the sperm collected to fertilize the ovule. The micropipette tip breaks the ovule membrane by inoculating the genetic material

MATERIALS AND METHODS

Aiming to reach the proposed goal, a device was developed for the manufacture of glass micro needles (Figure 3). The raw material used for its production consisted of borosilicate capillaries of 100 mm long (L), external diameter (OD) of 1.5 mm, and internal (ID) of 1.0 mm.

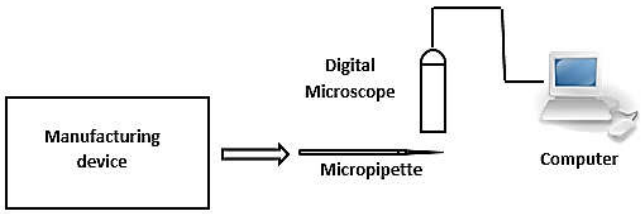

Figure 3. Device for manufacturing micro glass needles

The manufacture of micropipettes is associated with longitudinal deformation (distension) of the capillary. Knowing that the internal diameter of the orifice (ID) is inversely proportional to the said distension. Ten micropipettes were manufactured using a 20 mm capillary distension and the same number for capillary distension of 15 mm. The measurements of the internal diameters of the micropipettes tip were made using the DIGITAL MICROSCOPE ELETRONIC MAGNIFER 800x, with an error rated ±0.5 μm, associated to specific software of measurement and calibration that accompanies it.

RESULTS

Figure 4 shows one micropipette manufactured using the proposed device in a single procedure

Figure 4. Borosilicate micropipette manufactured using the device proposed

Figure 5 shows the images of two borosilicate micropipettes manufactured by the proposed device and processed with the measurement software that accompanies the microscope to quantify the orifice diameter of the micropipette tip. The images were acquired at a magnification of 300X. (a) Micropipette manufactured using a 20 mm capillary distention. (b) Micropipette manufactured using a 15 mm capillary distension. Figure 6 shows the tip orifice diameter distribution for the ten micropipettes produced using 20mm and15 mm capillary distension (a) for a capillary distension of 20 mm, the mean diameter was around 8.2 micrometers. (b) for a capillary distension of 15 mm the diameter was around 10.3 micrometers. Table 1 presents the estimated measurements of the tip orifice diameter of the micropipettes manufactured according to the capillary strains mentioned above. It also presents the mean value, the standard deviation and the percentage error for each case.

DISCUSSION

In analyzing Table 1, it can be concluded that the proposed device was able to produce homogeneous micropipettes with very close orifice diameters, with a maximum error of about 7%. The homogeneous character of the population of the micropipettes produced, attests to the operational viability of the device. In addition, there is a very important factor to be considered, the cost of a micropipette used in vitro fertilization is about $ 25.00 to 30.00, while the micropipette manufactured by the proposed device is around US $ 0.17, i.e. a cost almost 200 times lower than traditional brands of micropipettes found on the regular market. However, although the results achieved are quite significant, the proposed technique still has limitations. One of the important aspects not addressed in this article was the configuration of the tip of the micropipette, which is a very important aspect in relation to the role it will play in IVF.

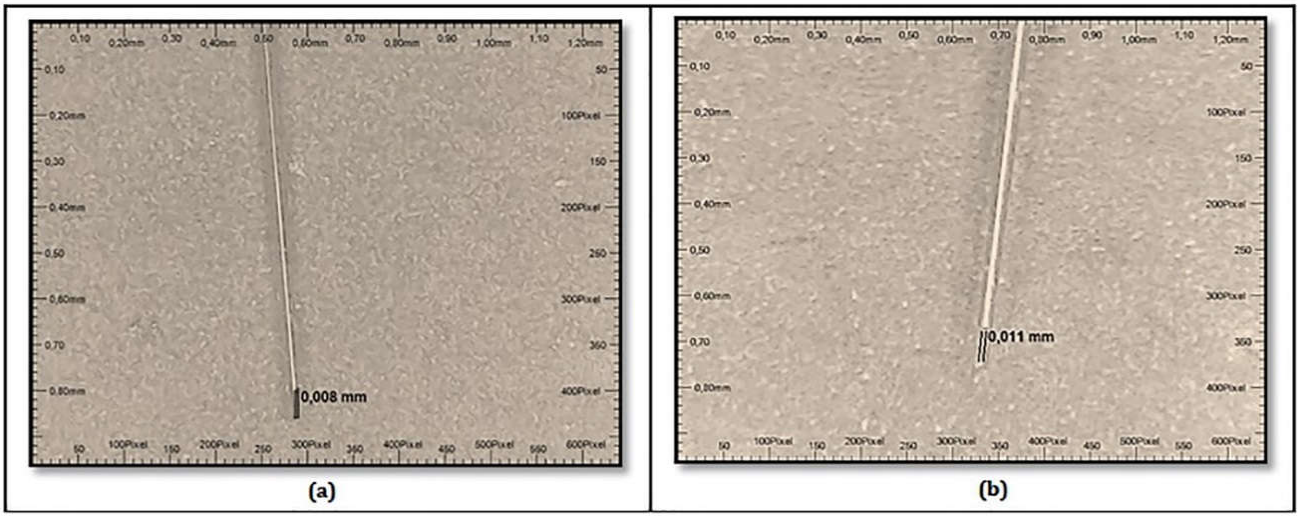

Figure 5. Image of two borosilicate micropipettes produced by the proposed device using 20 mm and 15 mm capillary distension

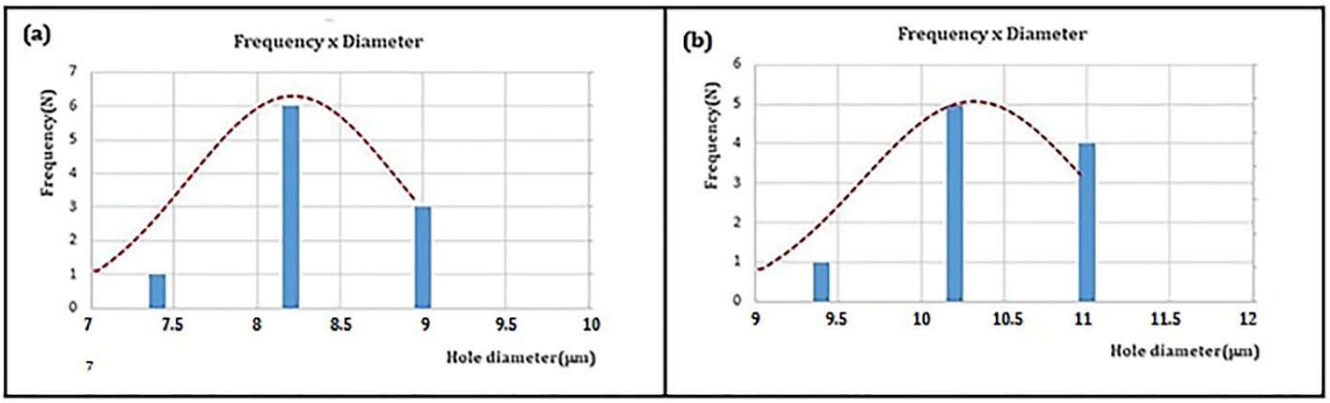

Figure 6. Tip orifice diameter distribution for the ten micropipettes produced using 20 and 15 mm capillary distension (a) for a capillary distension of 20 mm, the mean diameter was around 8.2 micrometers. (b) for a distension of 15 mm the diameter was around 10.3 micrometers

Table 1. Estimated measurements of micropipette tip orifice diameter for 20 mm and 15 mm capillary distention. The table also shows the mean value, standard deviation and percentage error reached in the measures

Manufactured needle (N)	Estimated diameter of tip hole diameter in mm (Capillary distension of 20 mm)	Estimated diameter of tip hole diameter in mm (Capillary distension of 15 mm)
1	8.0	10.0
2	8.0	9.0
3	9.0	10.0
4	8.0	11.0
5	9.0	10.0
6	7.0	11.0
7	8.0	10.0
8	8.0	10.0
9	8.0	11.0
10	8.0	10.0
Standard deviation [δ]	0.57	0.63
Average value[µm]	8.2	10.2
Percent error [%]	7.03	6.17

The process of adjusting the tip of the micropipette has a significant degree of difficulty due to the dimensions involved in the manufacturing process, associated to the polishing and its uniformity. Despite the limitations pointed out, the proposed device fulfilled the main objective, which was to manufacture borosilicate micropipettes with the compatible dimensions for use in activities linked to microbiology with emphasis on assisted reproduction (in vitro fertilization). The device was able to manufacture micropipettes with orifice diameter of less than 10μm, with a much lower individual cost than those sold on the regular market. As this initiative is in an early stage of development, it is necessary to delineate some of the limitations, notably related to the standardization of micropipette tips. The overcoming of the problem of the uniformity of the tips of the micropipettes encourages the continuity of this work to manufacture micropipettes compatible with those offered in the market, at a much lower individual cost, which will certainly reflect in the reduction of the procedural cost related to the treatment of human reproduction Assisted.

Acknowledgements

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Conflict of Interest

We declare no financial interest or any conflict of interest.

REFERENCES

Bleil, Jeffrey D. 1993. "[14] In vitro fertilization." Methods in Enzymology, 225: 253-263.

Dandekar, Pramila V. and Martin M. Quigley, 1984. "Laboratory setup for human in vitro fertilization." FertilSteril 42.1

Griffiths, T. A., Murdoch, A. P. and Herbert, M. 2000. "Embryonic development in vitro is compromised by the ICSI procedure". *Human Reproduction*, 15(7), 1592-1596.

Keijzer, C. J., Reinders, M. C. and Leferink-ten Klooster, H. B. 1988. "A micromanipulation method for artificial fertilization in Torenia." Sexual reproduction in higher plants. Springer, Berlin, Heidelberg, 119-124.

Kühnert, M. 1991. Demonstration of new techniques using instrumental insemination. Apiacta XXVI (1), 2-7

McAllister, Devin V., *et al*. 2003. "Micro fabricated needles for transdermal delivery of macromolecules and nanoparticles: fabrication methods and transport studies." Proceedings of the National Academy of Sciences 100.24: 13755-13760.

Metka, M., *et al*. 1987. "Artificial insemination using a micromanipulator." Future Aspects in Human in Vitro Fertilization," W. Feichtinger and P. Kemeter eds., Springer Verlag, Berlin, Heidelberg: 119-121.

O'Brien, Marilyn J., Janice K. Pendola and John J. Eppig, 2003. "A revised protocol for in vitro development of mouse oocytes from primordial follicles dramatically improves their developmental competence." *Biology of Reproduction,* 68.5: 1682-1686.

Palanker, Daniel, *et al*. 1991. "Technique for cellular microsurgery using the 193-nm excimer laser."*Lasers in Surgery and Medicine,* 11.6: 580-586.

Roux, C., *et al*. 1995."Morphometric parameters of living human in-vitro fertilization embryos; importance of the asynchronous division process." Human reproduction (Oxford, England) 10.5: 1201-1207.

Schrlau, Michael G. *et al*. 2007. "Carbon Nano pipettes for cell probes and intracellular injection." *Nanotechnology,* 19.1: 015101.

Trounson, A. O. *et al*. 1981. "Pregnancies in humans by fertilization in vitro and embryo transfer in the controlled ovulatory cycle." *Science*, 212.4495: 681-682.

Yaun M., Batthi, R. and Lawrence, S. 2008. Evaluating the process of polishing borosilicate glass capillaries used for fabrication of in-vitro fertilization (IVF) micropipettes. Biomed Micro devices, 10(1):123-8.

Zegers-Hochschild, Fernando, *et al*. 2009. "The international committee for monitoring assisted reproductive technology (ICMART) and the world health organization (WHO) revised glossary on ART terminology," *Human Reproduction*, 24.11 2683-2687.

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