Portable Optoelectronic Tweezers (OET), taking optical micromanipulation out of the optics lab

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Summary

We report the development of a portable optical micromanipulation setup based on Optoelectronic Tweezers (OET). We show multiple microparticle manipulation in a setup that fits within a briefcase and demonstrate its potential for facilitating interdisciplinary science by reducing the effort required to explore new applications.

Introduction

Micromanipulation, the control of microparticles, is an important aspect of the lab-on-a-chip research field providing researchers with a virtual pair of hands with which to explore microscopic biological samples. Several physical forces are being actively investigated including optical forces, electrical forces, acoustic forces, magnetic forces and physical forces using an AFM tip. One common hurdle these techniques face is that they are often developed in physical science and engineering labs but are designed to work with biological specimens which are easier to handle in a well equipped biology lab. There is a growing push towards interdisciplinary science and an increasing number of institutions that are well equipped to work with biological samples in an engineering environment however it is still useful for an engineer to be able to quickly try out a new application with a potential life sciences collaborator by taking their equipment into the bio lab where they other equipment necessary to work with the samples. With this motivation we have created a portable version of our Optoelectronic Tweezers (OET) setup.

OET is a method of optically patterning dielectrophoresis forces by the patterned illumination of a photoconductive device [1]. The optical pattern increases the conductivity of the photoconductor which causes an applied electrical field to be concentrated above the illuminated regions allowing them to act as repositionable electrodes. This contrasts to traditional dielectrophoresis devices which use static electrodes providing some of the flexibility of using optical forces whilst still retaining the benefits of dielectrophoresis e.g. the ability to tune the force by changing the frequency of the applied field and the advantage of not requiring high powered lasers, an important aspect in this project to create a portable system.

Discussion

The portable OET setup is shown in figure 1a) and uses a Dell M110 mini data projector as the light source and light patterning device. The projection optics have been removed from the front of the projector allowing the light to be focused through a 20x objective (Olympus, 0.4 N.A.). The device is imaged with a simple microscope built from optomechanics (Thorlabs GmbH) that uses a 10x objective (Olympus 0.25 N.A.) and uses brightfield illumination from an LED source.

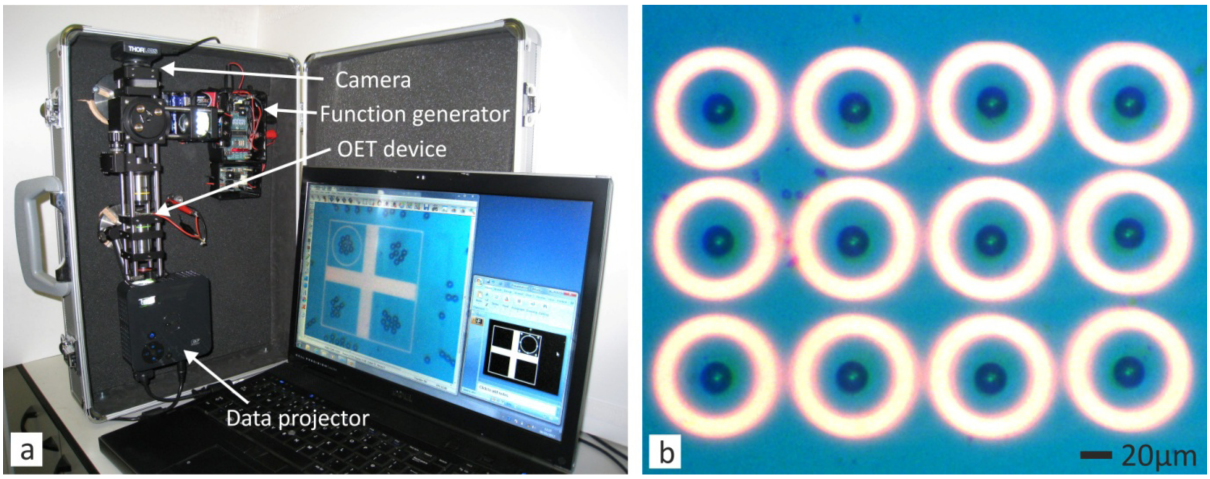

Fig 1 a) the portable OET setup built within a briefcase, b) 20µm diameter beads being manipulated.

The applied electrical field is created by a small battery powered function generator and 1W amplifier (N42FL and N48FL respectively from Maplin) which when powered with 12V were capable of producing up to 9Vpp at frequencies up to 78kHz. All of the components of this system are battery powered except the data projector which requires one power socket; in the future it will be possible to replace this with a battery powered data projector as these are getting increasing more powerful as they are developed for the mobile entertainment industry. We found that this was sufficient to move 20µm diameter beads at up to 69µms^{-1} equivalent to a force of 13.0pN ±0.5pN. In figure 1b) we show that it is also possible to trap multiple particles simultaneously with this system.

Conclusions

We have demonstrated a portable optical micromanipulation system. Its ability to create a complicated and continually reconfigurable pattern of forces is anticipated to be of use in many biological applications which it will be easier to investigate due to this systems portability.

References

P.Y. Chiou, et al. *Nature*, 436, p370-2, 2005.

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