



Finite difference time domain modeling of light matter interaction in light-propelled microtools

Bañas, Andrew Rafael; Palima, Darwin; Aabo, Thomas; Glückstad, Jesper

Published in:

MASOMO - Modeling, Analysis, and Simulation of Optical Modes in Photonic Devices

Publication date:

2013

Document Version

Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):

Bañas, A. R., Palima, D., Aabo, T., & Glückstad, J. (2013). Finite difference time domain modeling of light matter interaction in light-propelled microtools. In *MASOMO - Modeling, Analysis, and Simulation of Optical Modes in Photonic Devices: Abstracts WIAS - Weierstrass Institute for Applied Analysis and Stochastics*.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Finite difference time domain modeling of light matter interaction in light-propelled microtools

Andrew Bañas, Darwin Palima, Thomas Aabo, Jesper Glückstad

DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark
Programmable Phase Optics www.ppo.dk, Ørsteds Plads, DK-2800, Kongens Lyngby, Denmark
araf@fotonik.dtu.dk,

Direct laser writing and other recent fabrication techniques offer a wide variety in the design of microdevices. Hence, modeling such devices requires analysis methods capable of handling arbitrary geometries. Recently, we have demonstrated the potential of microtools, optically actuated microstructures with functionalities geared towards biophotonics applications. Compared to dynamic beam shaping alone, microtools allow more complex interactions between the shaped light and the biological samples at the receiving end. For example, strongly focused light coming from a tapered tip of a microtool may trigger highly localized non linear processes in the surface of a cell. Since these functionalities are strongly dependent on design, it is important to use models that can handle complexities and take in little simplifying assumptions about the system. Hence, we use the finite difference time domain (FDTD) method which is a direct discretization of the fundamental Maxwell's equations applicable to many optical systems. Using the FDTD, we investigate light guiding through microstructures as well as the field enhancement as light comes out of our tapered wave guide designs. Such calculations save time as it helps optimize the structures prior to fabrication and experiments. In addition to field distributions, optical forces can also be obtained using the Maxwell stress tensor formulation. By calculating the forces on bent waveguides subjected to tailored static light distributions, we demonstrate novel methods of optical micromanipulation which primarily result from the particle's geometry as opposed to the directly moving the light distributions as in conventional trapping.

KEYWORDS

Microfabrication, Optical trapping, Finite difference time domain, Maxwell stress tensor

REFERENCES

- [1] D. Palima, and J. Glückstad. Gearing up for optical microrobotics: micromanipulation and actuation of synthetic microstructures by optical forces, *Laser & Photon. Rev.*, doi: 10.1002/lpor.201200030 (published online 7 Jan 2013).
- [2] D. Palima, A.R. Bañas, G. Vizsnyiczai, L. Kelemen, T. Aabo, P. Ormos, and J. Glückstad. Optical forces through guided light deflections, *Opt. Express*, 21, 581-593 (2013).
- [3] D. Palima, A. R. Bañas, G. Vizsnyiczai, L. Kelemen, P. Ormos, and J. Glückstad, Wave-guided optical waveguides, *Opt. Express*, 20, 2004-2014 (2012).
- [4] J. Glückstad, Optical manipulation: Sculpting the object, *Nature Photonics*, Vol. 5, 7-8 (2011).