PHYSICAL REVIEW E **74**, 036504 (2006)

Electromagnetic forces on the dielectric layers of the planar optical Bragg acceleration structure

Amit Mizrahi* and Levi Schächter
Department of Electrical Engineering, Technion—Israel Institute of Technology, Haifa 32000, Israel
(Received 12 May 2006; published 27 September 2006; publisher error corrected 28 September 2006)

Optical Bragg acceleration structures are waveguides with a vacuum core and dielectric layers as a cladding, designed to guide laser light at the speed-of-light TM mode and accelerate charged particles. In this study, we analyze the electromagnetic forces exerted on the dielectric layers of a planar structure by both the guided laser light and the wake-field of moving charges. The distribution of the volume force densities, as well as the surface force densities, in the interfaces between the layers as a result of the laser propagation is given, and analytic scaling laws for the maximal values are obtained. Separation of the wake-field into the structure's eigenmodes is essential in order to determine the different contributions of the wake-field to the total impulse that acts on the structure. It is shown that the impact of the wake-field on the structure results almost entirely from the fundamental TM mode. While the total force on the dielectric layers may be significantly stronger than the gravitational force, we show that for typical structures, the pressures that develop are orders of magnitude below the damage threshold.

DOI: 10.1103/PhysRevE.74.036504 PACS number(s): 29.17.+w, 41.75.Lx, 03.50.De, 78.70.−g