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Introduction


Optotune develops, manufactures and markets adaptive optical elements. Our patented technology based on electroactive polymers enables the implementation of a revolutionary lens with tunable focal length. Its principle is similar to that of the human eye: Instead of moving lenses back and forth, we bend them by applying a voltage. This additional degree of freedom simplifies the design of focus and zoom systems in many applications, outperforming existing solutions in terms of size, cost, power consumption and robustness.

	Mobile Phones	Microscopes	Endoscopes
Problem	Optical zoom units are <ul style="list-style-type: none"> • Design limiting • Fragile • Power consuming • Expensive 	Different zoom ranges require switching between objectives <ul style="list-style-type: none"> • Expensive 	Size limitation prohibits mechanical focus & zoom systems <ul style="list-style-type: none"> • Movement increases patient's stress
Desire	Robust, low-cost, integrated optical zoom	Affordable objectives with larger zoom range	Miniaturized focus & zoom systems

Our vision
Revolutionize the market for optical systems by replacing mechanical focus and zoom systems with a focus-tunable lens system



1st generation
Glass



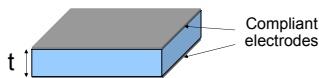
2nd generation
Plastic



3rd generation
Elastic polymers

Theory

Voltage off



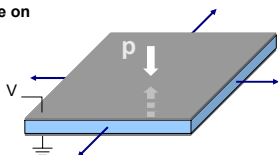
Effective Field Pressure

$$p = \epsilon_r \epsilon_0 E^2 = \epsilon_r \epsilon_0 \left(\frac{V}{t}\right)^2$$

Thickness Strain

$$s_z = -\frac{p}{Y} = -\epsilon \epsilon_0 \frac{V^2}{Y t^2}$$

Voltage on

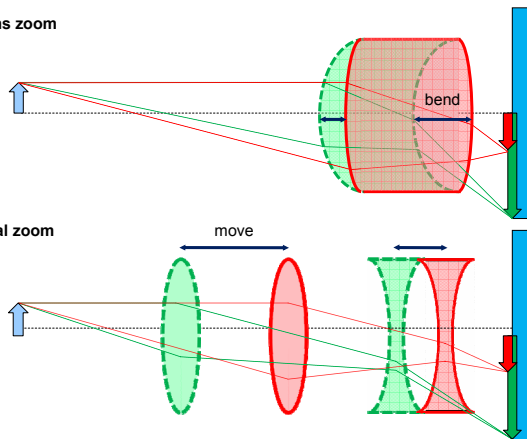


Lateral Strain

$$s_{xy} = \frac{1}{\sqrt{1 - \epsilon \epsilon_0 \frac{V^2}{Y t^2}}} - 1$$

A polymer can be expanded up to 40% by applying voltage

Single lens zoom



Traditional zoom

Commercialization



Phase shifter

A phase shifter is used to retard passing light. With our novel phase shifter, the delay of the light can be varied by adjusting a control voltage.



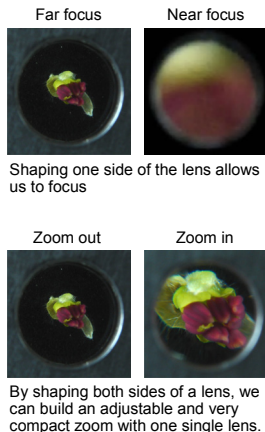
Manually focus-tunable lens

By turning a regulating ring, our manual lens changes its focal length from convex to flat to concave.



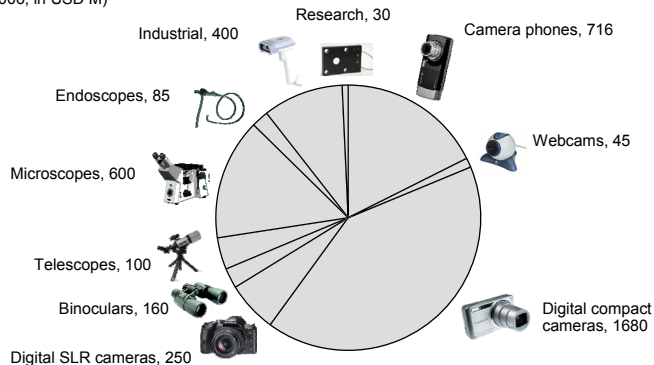
Electrically focus-tunable lens

Optotune presents the world's first focus tunable lens with a diameter > 3mm. The focal length of our electrical lens can be varied by adjusting a control voltage.



Global market for lenses by field of application (2006, in USD M)

Total: USD 4.1B



Source: IDC; Annual reports; Broker reports; Estimates

References:

M. Aschwanden: Tunable optical elements based on dielectric elastomer actuators, Diss. ETH No. 17519, 2007
M. Aschwanden and A. Stemmer, Opt. Lett., 31(17): 2610-2612, Sept. 2006.
M. Aschwanden and A. Stemmer. In Y. Bar-Cohen, editor, EAPAD, volume 6524. SPIE, April 2007.
M. Aschwanden, M. D. Beck, and A. Stemmer, IEEE Phot. Tech. Lett., 19(14):1090-1092, July – Aug. 2007.

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