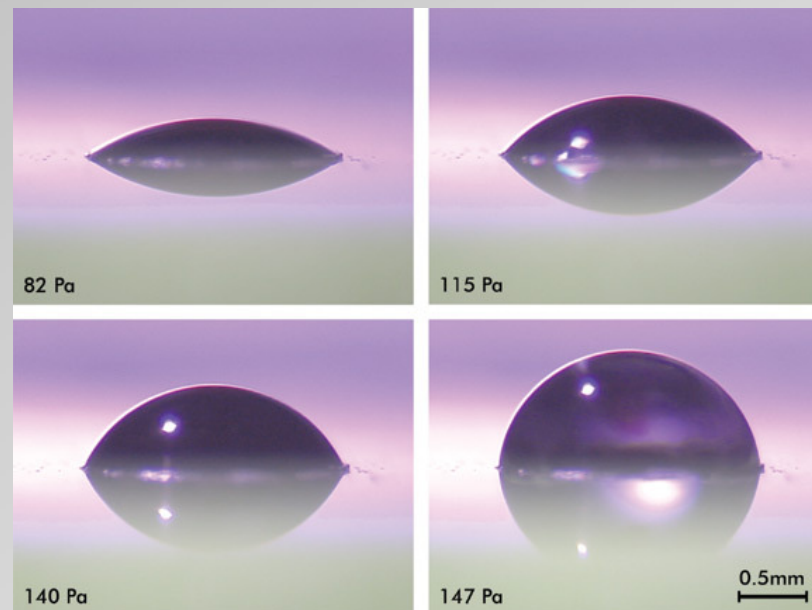


Liquid Lenses

Small variable-focus fluid lens
elements

What are liquid lenses

- Lens formed by the meniscus of a liquid
- Shape of the meniscus is manipulated by some external force



12/8/2006

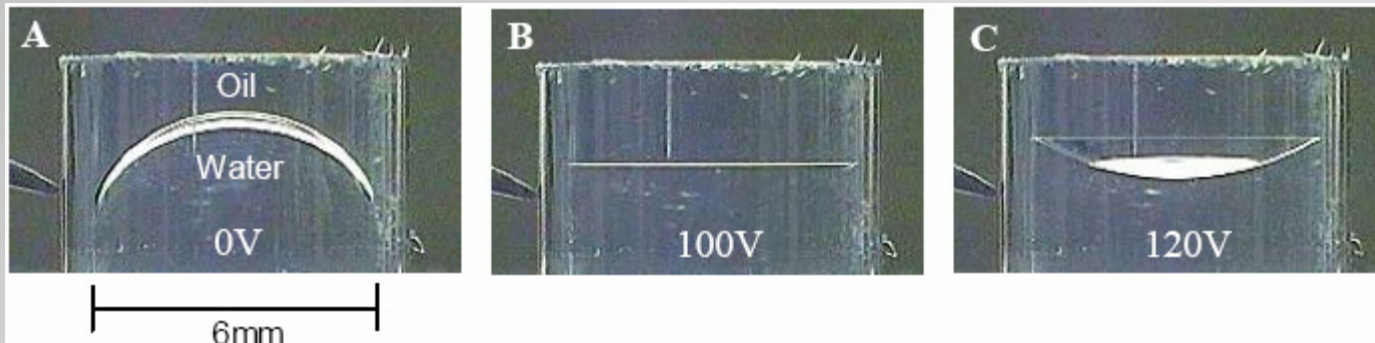
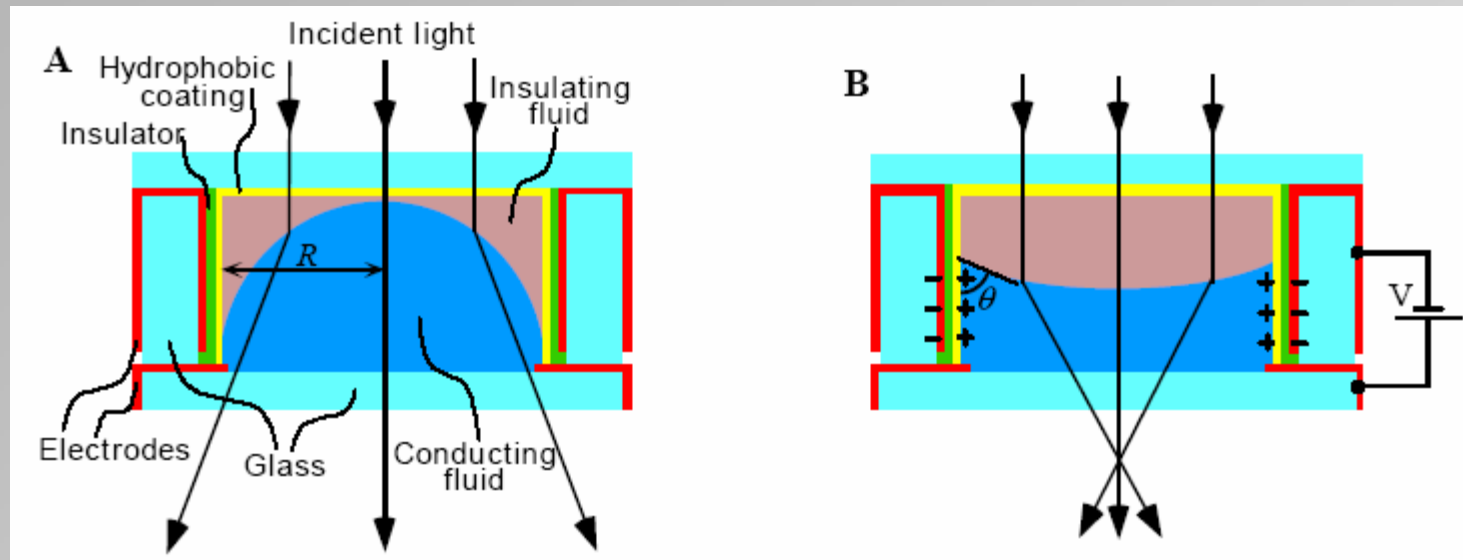
Leonard Zugby

2

Typical Application

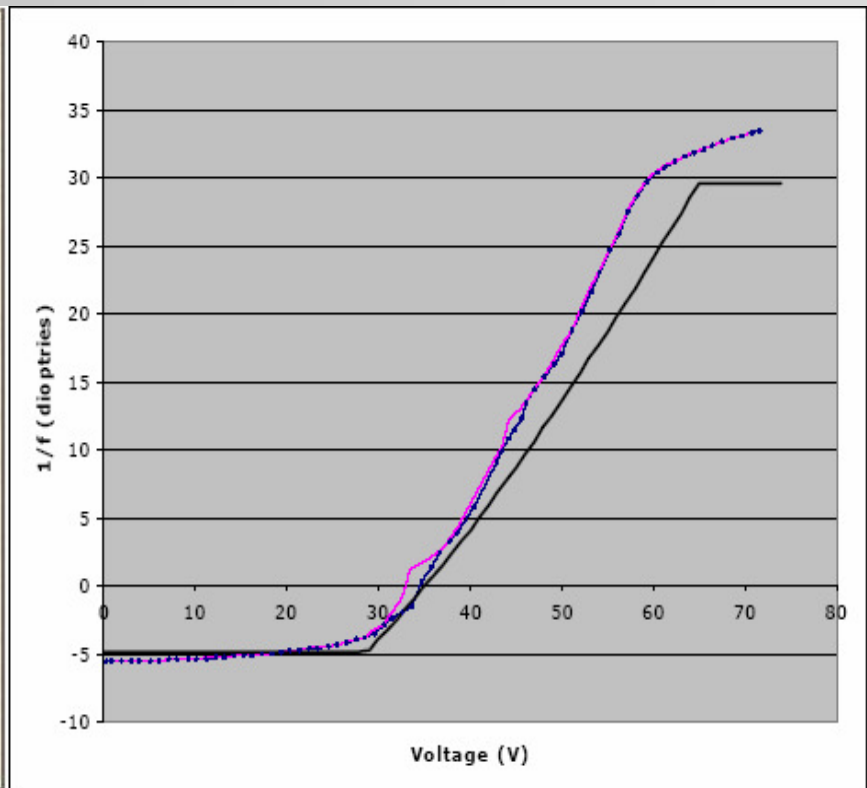
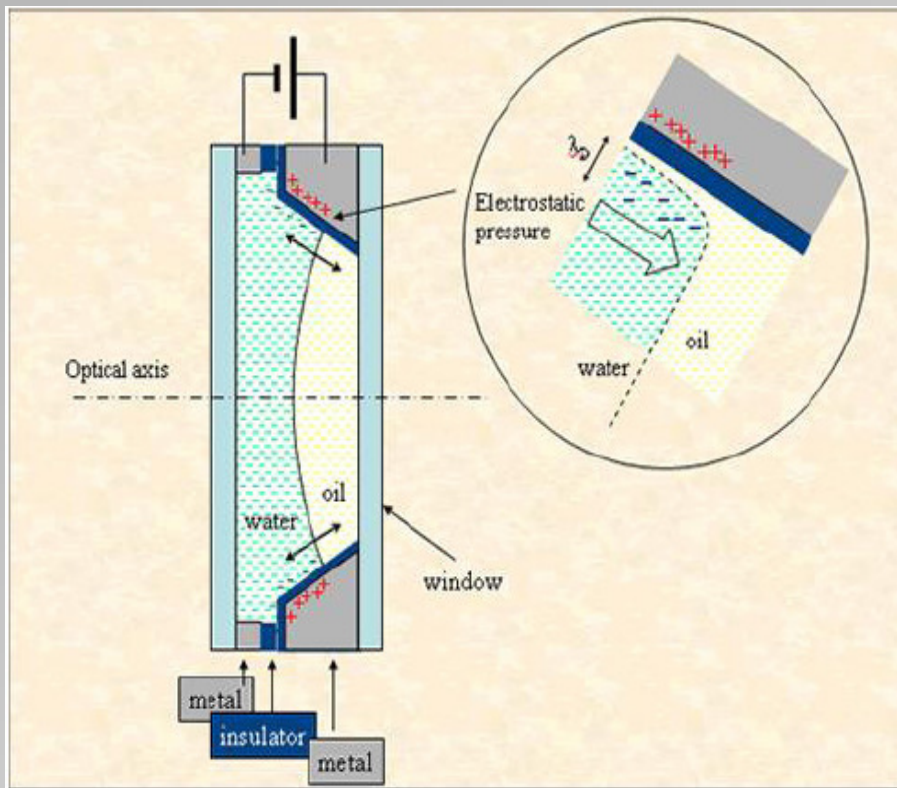
- Short tube with transparent ends
- Two immiscible fluids
- Different refractive indices
- One electrically conducting aqueous and one non-conducting oil
- Hydrophobic layer on one surface

Basic Design

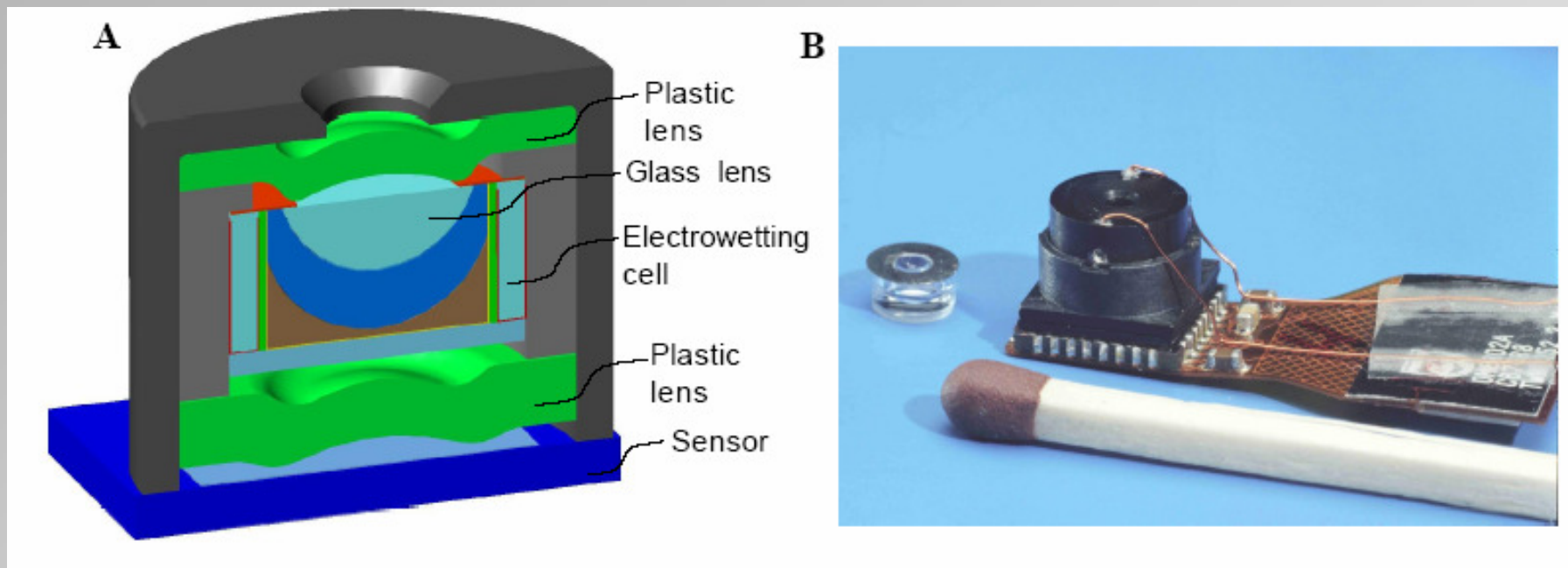


Electrowetting

- Electric field changes contact angle effectively changing the power



Liquid Lens and Assembled Camera Module



VGA CMOS Camera and Liquid Lens



50cm



5cm

Advantages

- No mechanical moving parts
- Inexpensive
- Small size
- Fast response



Typical Performance

Arctic 320

	Item	Unit	-20°C to +60°C
Mechanical	Pupil diameter	mm	3
	Dimensions	mm	Φ F10.5 x 2.5
Optical	Focal range	diopter	> 20
	Offset dioptric power	diopter	-5 \pm 3
	Wave front error (RMS)	μ m	< 0.5
	Minimum transmittance	%	> 90
Electrical	Driving voltage (at 1kHz)	V _{rms}	0 - 60
Environmental	Storage temperature	°C	-40 to +85
	Operating cycles		> 1,000,000

Note:

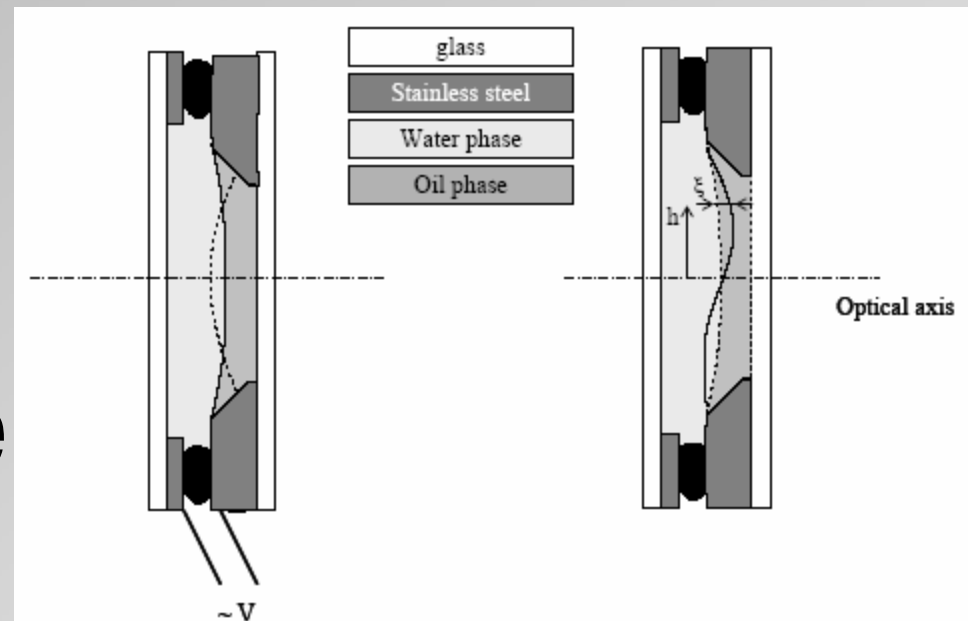
- Response time is 100ms typical
- Dissipated Power is < 1 mW typical

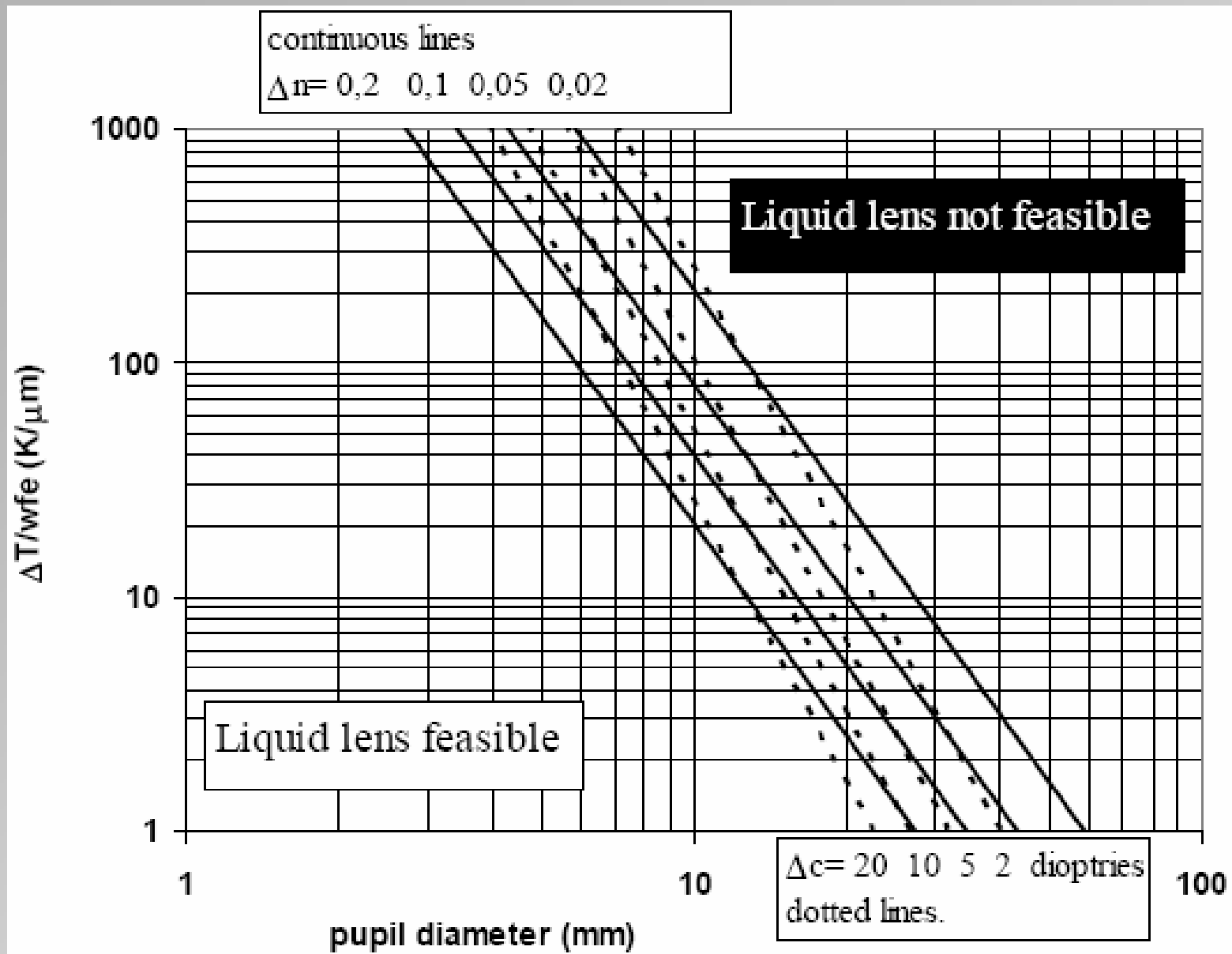
Uses

- Auto focus camera lens
 - Cell phone cameras
 - Security cameras
 - Webcams and other integrated cameras

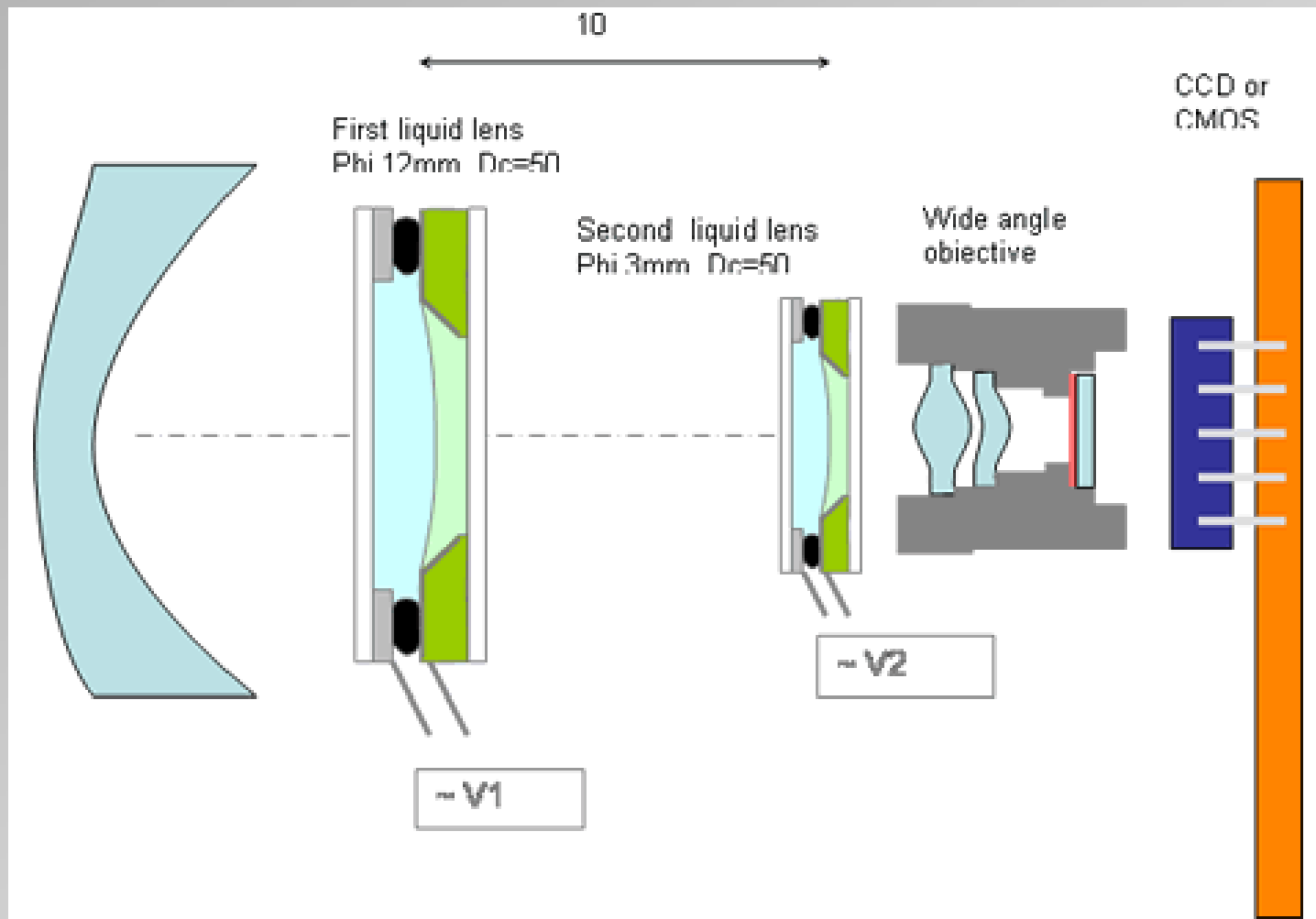
Design considerations

- Max size
- Density
- Temperature



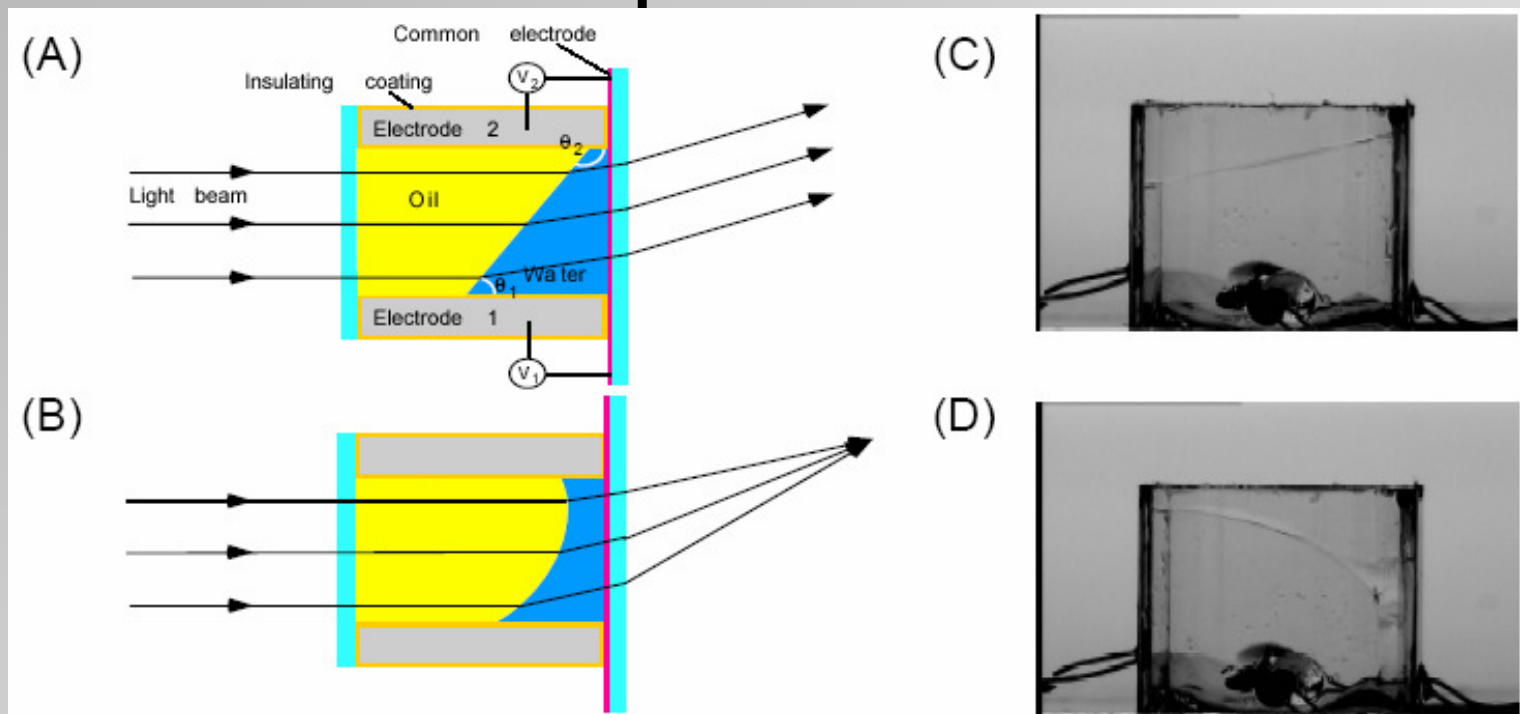


Varioptic Zoom Lens



Other uses

- Optical recording
- Illumination optics



References

S. Kuipera, B.H.W. Hendriks a, et al "Variable-focus liquid lens for portable applications" SPIE Vol. 5523 pp. 100-109, Oct 2004

Benno H.W. Hendriks, Stein Kuiper, et al "Variable liquid lenses for electronic products" SPIE Vol. 6034 Jan 2006

Jerome Crassous and Claude Garay "Liquid lens based on electrowetting: a new adaptive component for imaging applications in consumer electronics" SPIE Vol 5639 pp. 143-148, Dec 2004

www.varioptic.com

Questions?