



ECLSO 2022, Paris

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How can I select the best contact lens and replacement schedule for my patient?

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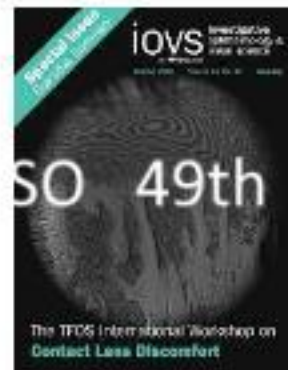
Carina Koppen MD PhD

Speaker for Alcon, B&L



Soft contact lens wear and comfort

TFOS Contact Lens Discomfort (CLD) Report 2013



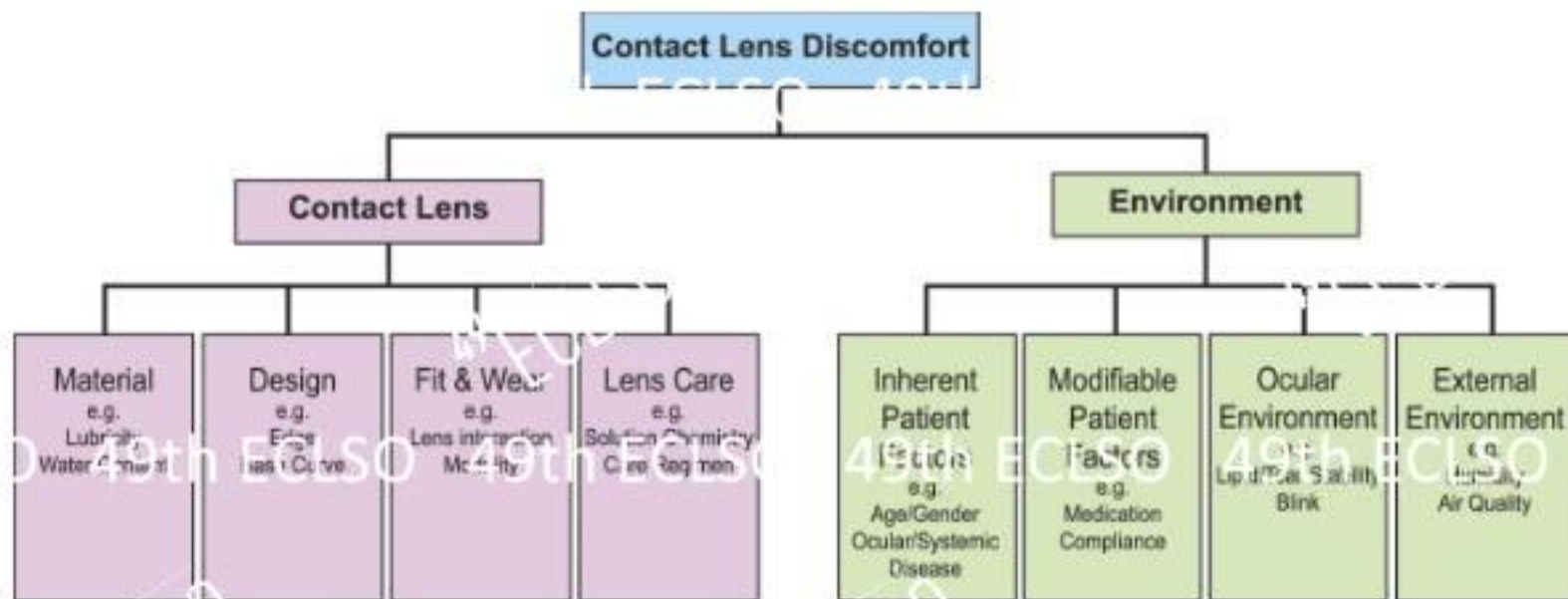
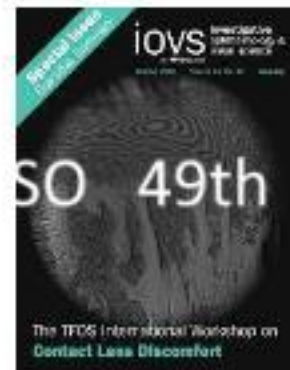
Contact lens discomfort is a condition characterized by episodic or persistent *adverse ocular sensations related to lens wear*, either with or without visual disturbance, resulting from *reduced compatibility between the contact lens and the ocular environment*, which can lead to decreased wearing time and discontinuation of contact lens wear

Progression of CLD



Soft contact lens discomfort and drop out

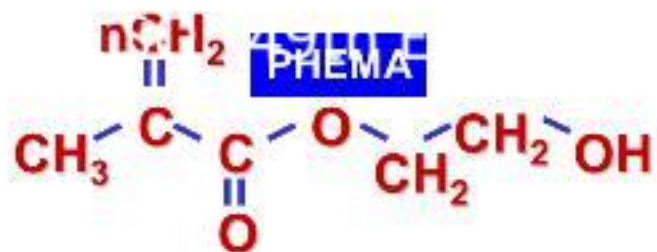
Predominant complication of lens wear: 30 to 80% of wearers
Contact lens discomfort is main reason for contact lens drop out



The origins of soft contact lenses: hydrogel material

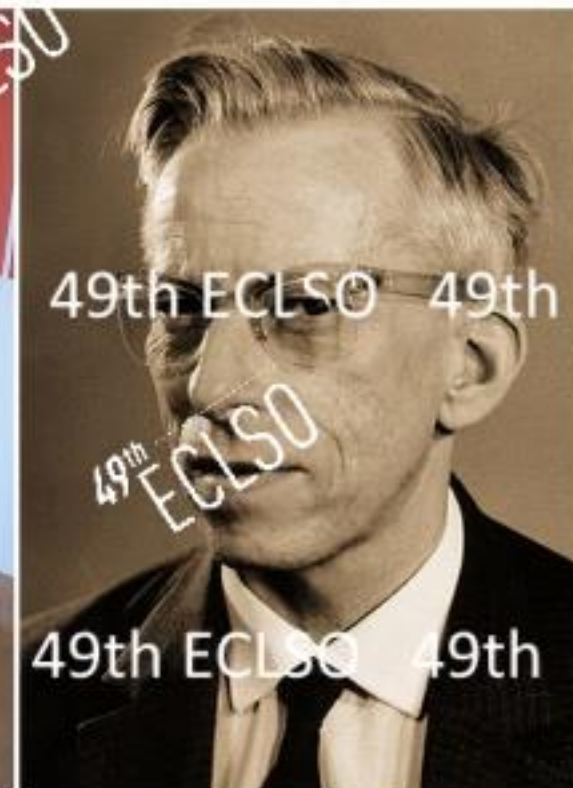
1961 Otto Wichterle

Spin casting of HEMA
hydrogel lenses



1971 FDA approval!

First commercial contact
lens

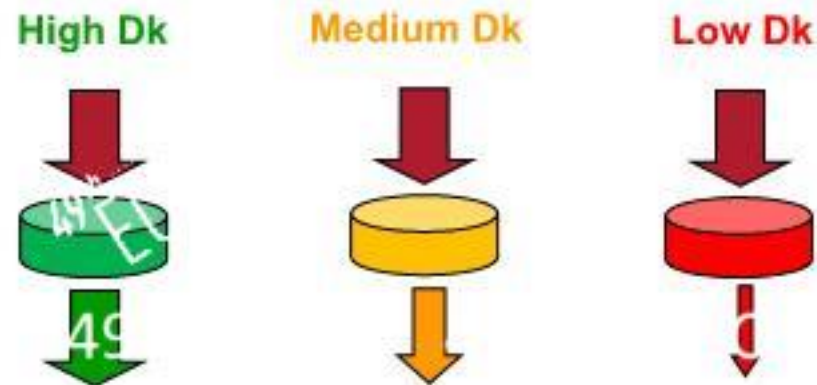


Material properties: oxygen permeability

Dk: Oxygen Permeability of a given MATERIAL

D: diffusion coefficient and k: solubility of oxygen

Units: 10^{-11} ($\text{cm}^2 \text{mlO}_2 \text{s}^{-1} \text{ml}^{-1} \text{mmHg}^{-1}$), "Fatt Units", Barrer



Lens properties: oxygen transmissibility

Dk/t: Oxygen Transmissibility of a given CONTACT LENS

Units: 10^{-9} (cm mlO₂ s⁻¹ ml⁻¹ mmHg⁻¹), Barrer/cm

Calculated from Dk and thickness (central/average or profile of lens)
Dk/t more clinically relevant



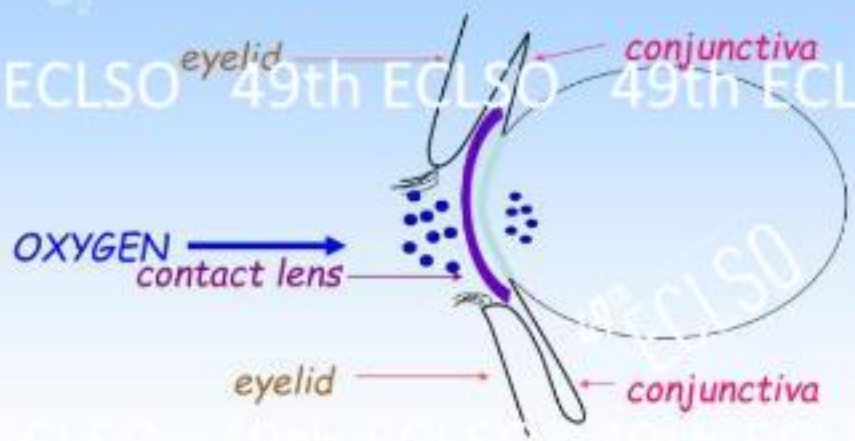
Corneal oxygen requirements



Corneal oxygen requirements

Daily wear contact lenses

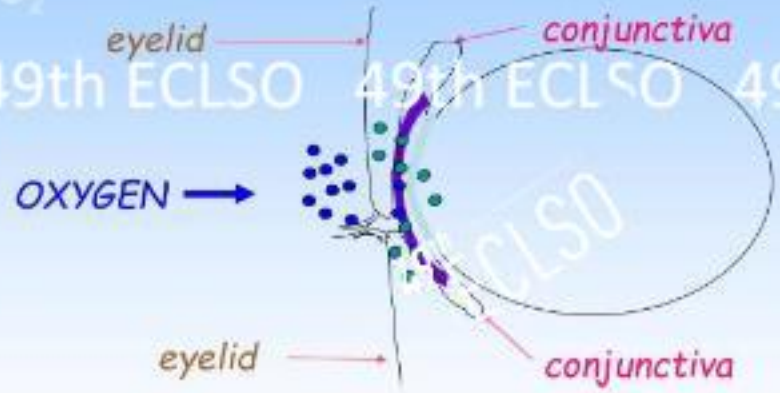
Lenses need to be oxygen permeable



Minimum Dk/t 24 for daily wear

Napping in contact lenses

Lenses need to be highly oxygen permeable



Minimum Dk/t of 87 for overnight wear

Hydrogel materials: copolymer characteristics

Hydrogel lenses FDA-classification

TABLE 6 Monomers and USAN for Common Hydrogel Contact Lens Materials

COMMERCIAL NAME	MANUFACTURER	USAN	WATER CONTENT	MONOMERS	FDA GROUP
Frequency 38	CooperVision	polymacon	38.0	HEMA	I
Optima Flex	CooperVision	polymacon	38.0	HEMA	I
ProSight	CooperVision	polymacon	42.0	HEMA + MMA + NVP	I
Biomedics 55	Ocular Sciences	ocufilcon D	55.0	HEMA + MA	IV
Focus (1-2 wks)	CIBA Vision	vifilcon	55.0	HEMA + PVP + MA	IV
1-Day Acuvue	Vistakon	etafilcon	58.0	HEMA + MA	IV
Acuvue 2	Vistakon	etafilcon	58.0	HEMA + MA	IV
Proclear Compatibles	CooperVision	omafilcon	62.0	HEMA + PC	II
Soflens 66	B&L	alphafilcon	66.0	HEMA + NVP	II
Focus Dailies	CIBA Vision	nefilcon	69.0	modified PVA	II
Soflens One Day	B&L	hilafilcon	70.0	HEMA + NVP	II
ProSight 1 Day	CIBA Vision	nefilcon	71.0	MMA + PVP	II

Key

HEMA	2-hydroxyethyl methacrylate	PC	phosphorylcholine
MA	methacrylic acid	PVA	polyvinyl alcohol
MMA	methyl methacrylate	PVP	polyvinyl pyrrolidone
NVP	N-vinyl pyrrolidone		

TABLE 5 FDA Classification of Hydrogel Contact Lens Materials

	WATER CONTENT (%)
Group I	Low water content, non-ionic < 50
Group II	High water content, non-ionic > 50
Group III	Low water content, ionic < 50
Group IV	High water content, ionic > 50

Hydrogel materials: copolymer characteristics

Hydrogel lenses: oxygen permeability increases with water content

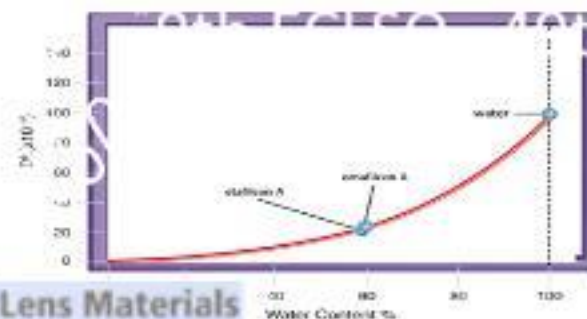
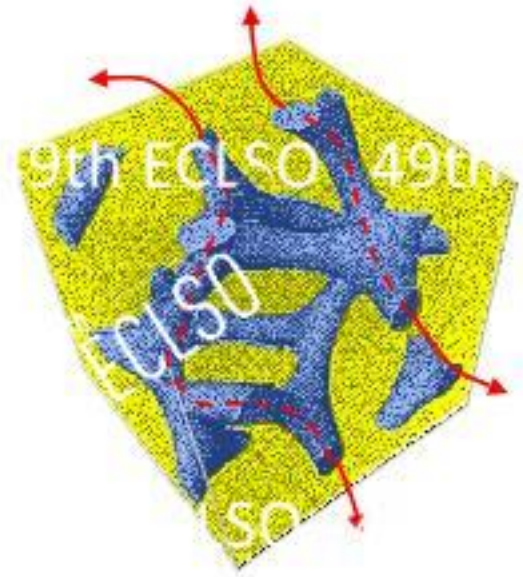
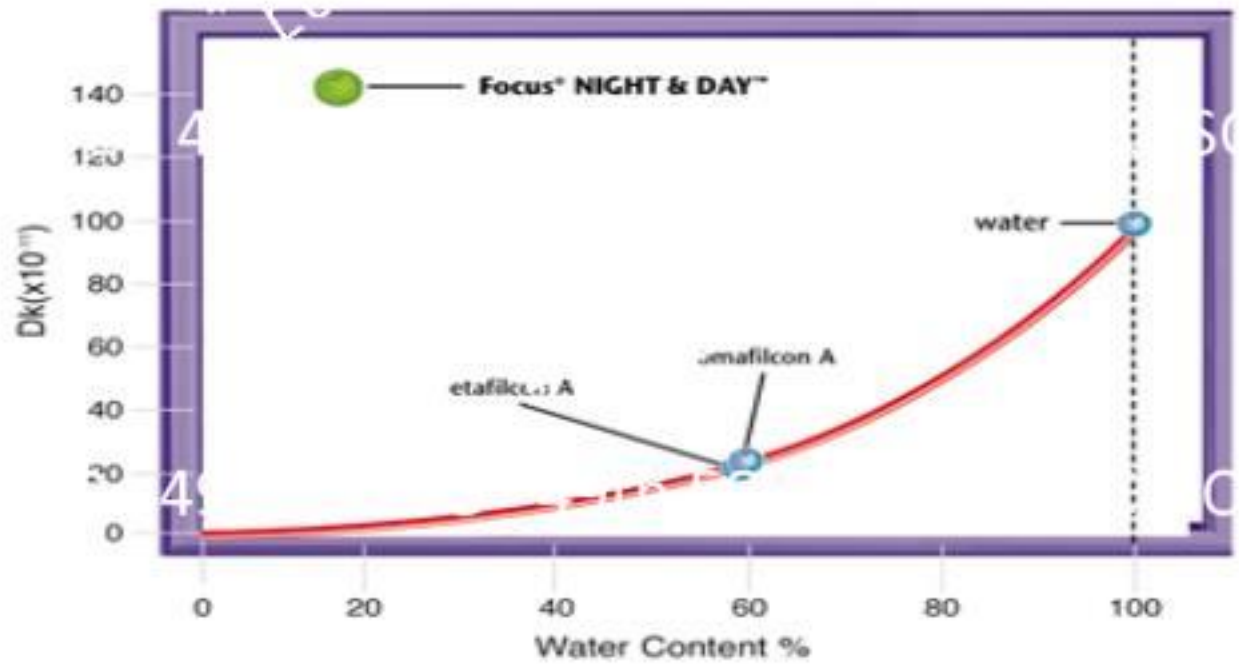


TABLE 2 Dk & Dk/t Values of Common Conventional Hydrogel Contact Lens Materials

COMMERCIAL NAME	MANUFACTURER	WATER CONTENT	Dk (EDGE CORRECTED)	C.T.	Dk/T
Freemery 3C	CooperVision	31.0	7.5	0.070	10.7
Optima FW	Bausch & Lomb	38.0	7.5	0.035	21.4
Preference	CooperVision	42.5	9.0	0.060	15.0
Biomedics 55	Ocular Sciences	55.0	14.8	0.070	21.1
Focus (1-2 wks)	CIBA Vision	55.0	14.8	0.060	24.7
Focus Monthly	CIBA Vision	55.0	14.8	0.100	14.8
1-Day Acuvue	Vistakon	58.0	16.7	0.070	23.9
Acuvue 2	Vistakon	58.0	16.7	0.084	19.9
Surevue	Vistakon	58.0	16.7	0.105	15.9
Proclear Comfortlens	CooperVision	63.0	19.6	0.065	30.2
Focus 66	Bausch & Lomb	66.0	21.9	0.100	22.1
Focus Dailies	CIBA Vision	69.0	26.9	0.100	26.9
Soflens One Day	Bausch & Lomb	70.0	26.9	0.170	15.8
Precision UV	CIBA Vision	74.0	31.5	0.140	22.5

Siliconehydrogel materials

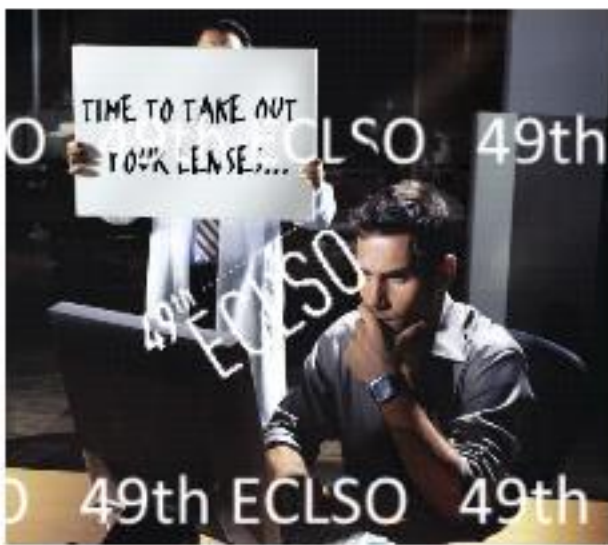
High oxygen permeability, low water content



©Ciba Vision

Siliconehydrogel materials

Hydrogel versus siliconehydrogel material lenses



Contact lens properties: modulus

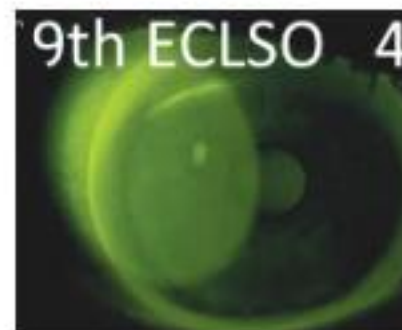
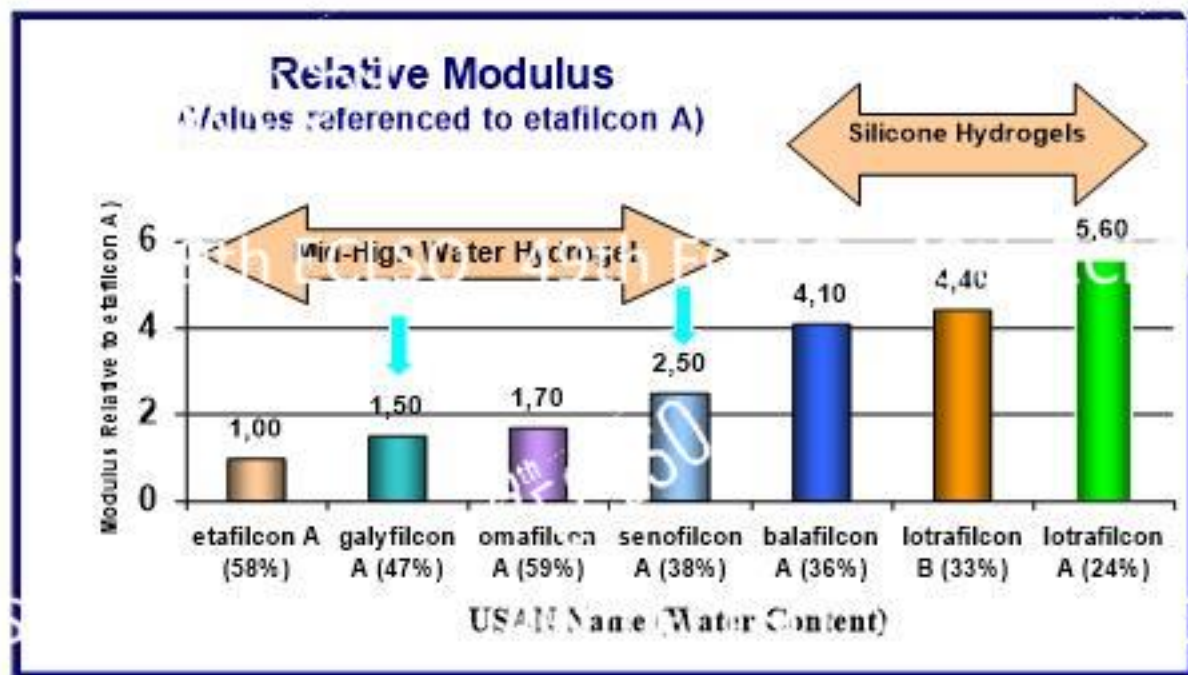


Figure 1. Superior arcuate corneal staining in a silicone hydrogel-wearing eye. White arrow indicates area of pressure and corresponding staining.



Figure 2A. Lotrafilcon A lens (Night & Day), 8.4mm BC, -6.50D diagnostic lens (arrow indicates edge fluting).

Contact lens properties: modulus



TABLE 1. GENERATIONS OF SILICONE HYDROGEL LENSES

First Generation	Second Generation	Third Generation
Lotrafilcon A (Dk = 140) Balafilcon A (Dk = 51)	Galyfilcon A (Dk = 60) Senofilcon A (Dk = 103)	Comfilcon A (Dk = 128) Asmafilcon A (Dk = 125) Eufilcon A (Dk = 106) Samfilcon A (Dk = 163)
Low water content (24%–36%)	Higher water content (38%–47%)	Higher water content (40%–48%)
High modulus (1–1.5 Mpa)	Lower modulus (0.43–0.73 Mpa)	Lower modulus (0.50 to 0.75 Mpa)
Plasma surface treatment	Internal wetting agent (PVP)	Nanogloss surface treatment or naturally wettable silicone
30-day continuous wear	6-day extended wear	6-day extended wear

Abbreviations: Dk = oxygen permeability; Mpa = megapascal; PVP = polyvinylpyrrolidone

Material properties: wettability

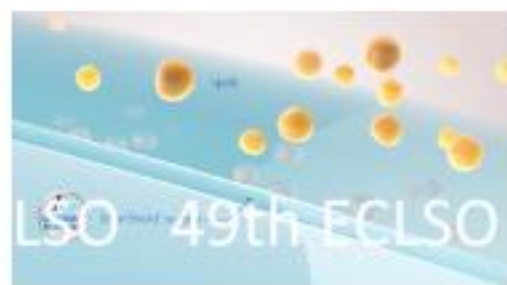
Wettability = allowing the tear film to spread easily and maintain itself over the lens

Plasma treatment of the surface

Integrating wetting agents

Incorporation of hydrophilic monomers

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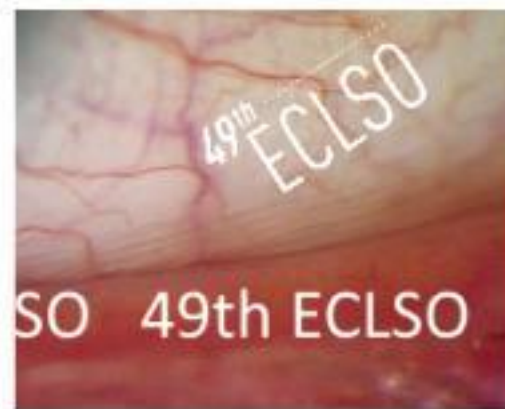
Hydrophilic material
Oxygen molecules
Silicone channels



Material properties: coefficient of friction

Lubricity = allowing the eye lid to move smoothly across the front surface of the lens without irritation

Lens friction may be associated with clinically observable conditions, including lid wiper epitheliopathy and lid parallel conjunctival folds.



Material properties: deposition

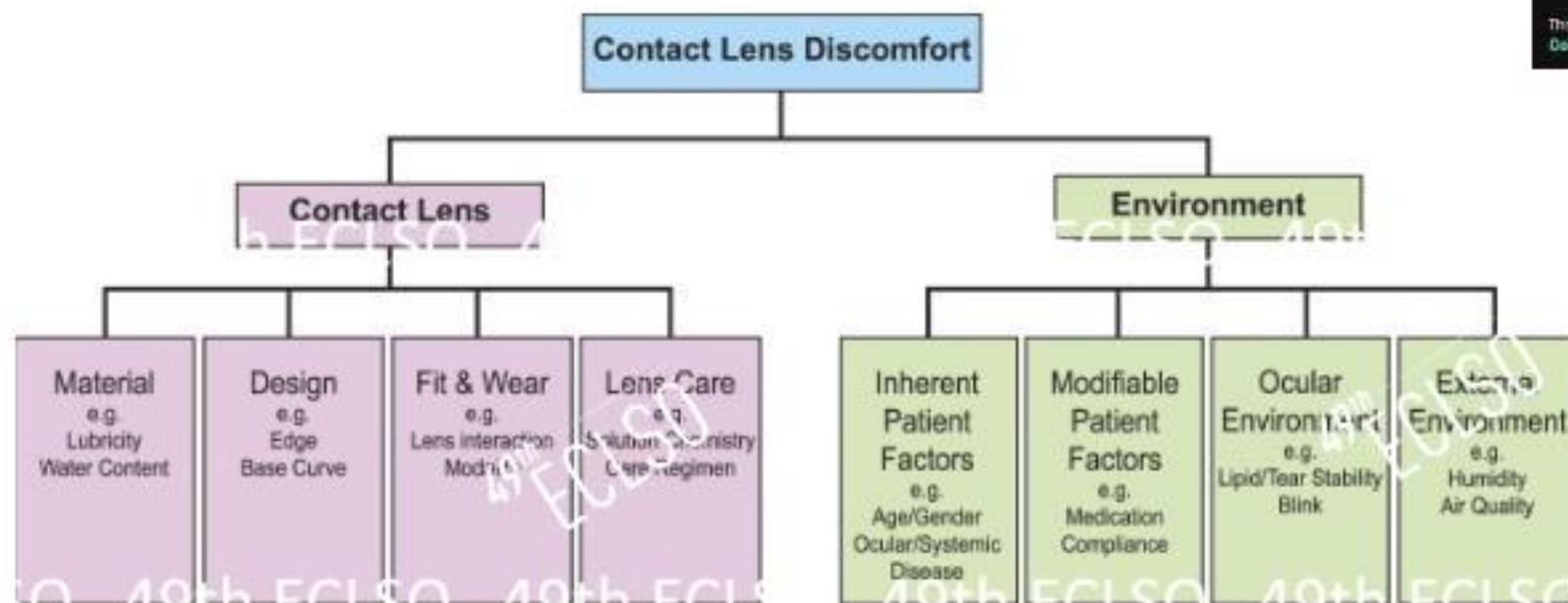
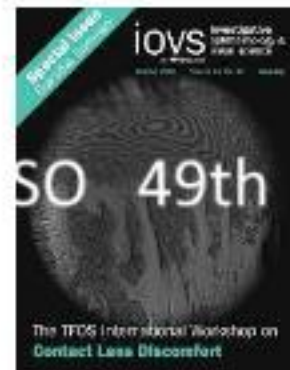
Hydrogel versus siliconehydrogel material lenses



Figure 1. Schematic illustration of trends in lipid and protein deposits on different contact lens materials (After Mann A and Tighe B. Contact lens interactions with the tear film. Experimental Eye Research, 2013;117:88-98)



TFOS Contact Lens Discomfort Report 2013



Modalities of lens wear and replacement

Disposable lenses: single use (for a day or for up to 4 weeks)

Reusable lenses: disinfection with contact lens solutions

Daily wear: taking out lenses for sleeping

Extended wear: sleeping with lenses in

Time line of soft contact lenses

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Material released	1971	1987	1996	1998	1998	2005	2007	2011	2012	2013	2014	2019	2020
Polymacon													
etafilcon													
neofilcon													
balafilcon													
lotrafilcon													
senofilcon													
comfilcon													
delefilcon													
nesofilcon													
stenfilcon													
samfilcon													
verofilcon													
Kalifilcon													

Dates based upon manufacturers own published data

International Prescribing of Soft Contact lens

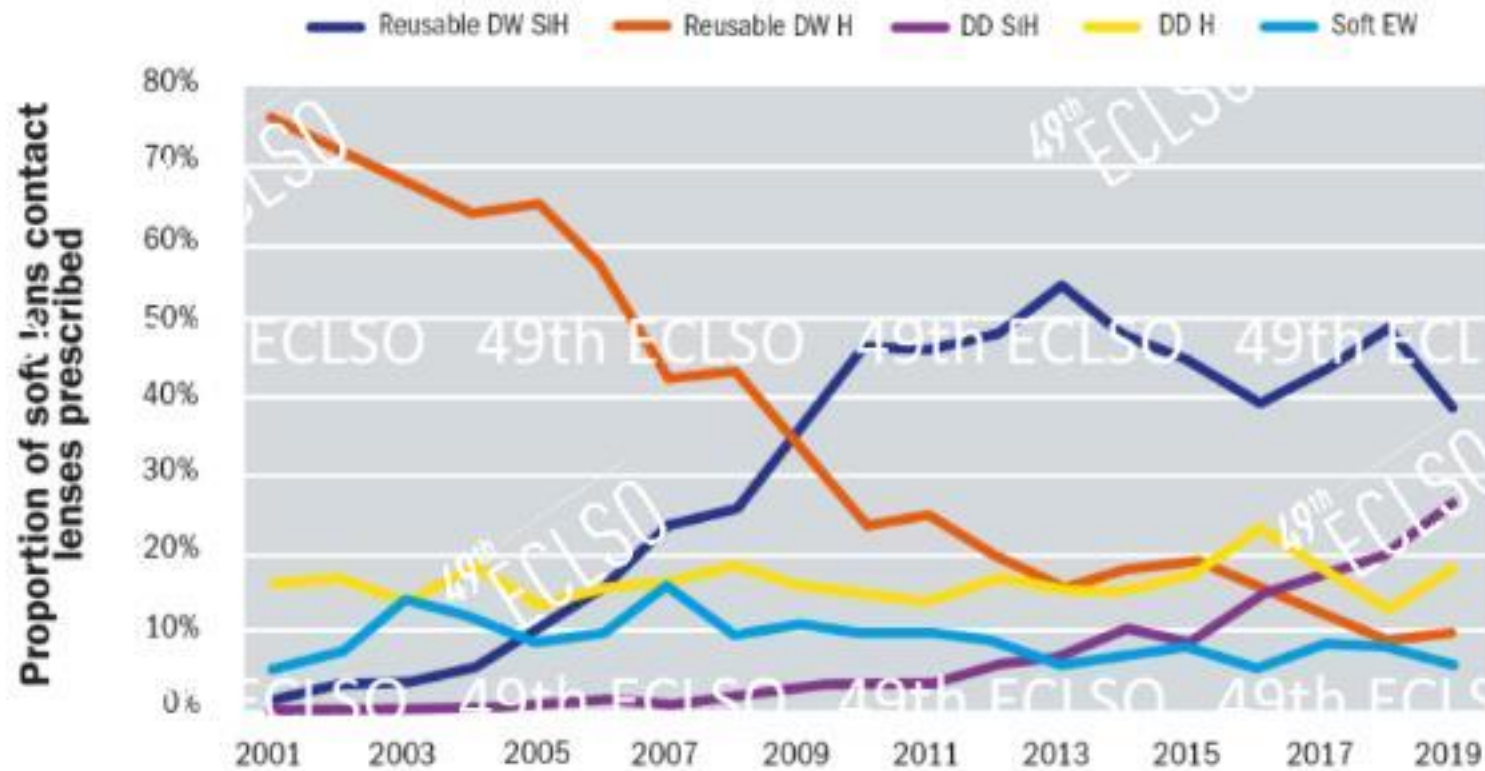


Figure 1: International Prescribing of Soft Contact Lenses 2001 to 2019. Data provided by the International Contact Lens Prescribing Trends Consortium¹³

Benefits of daily disposable contact lenses

Convenience and better compliance

- No need to clean, rinse or disinfect
- No lens solutions and no lens cases
- Spare lenses always available

No solution related complications

Less accumulation of lens deposits

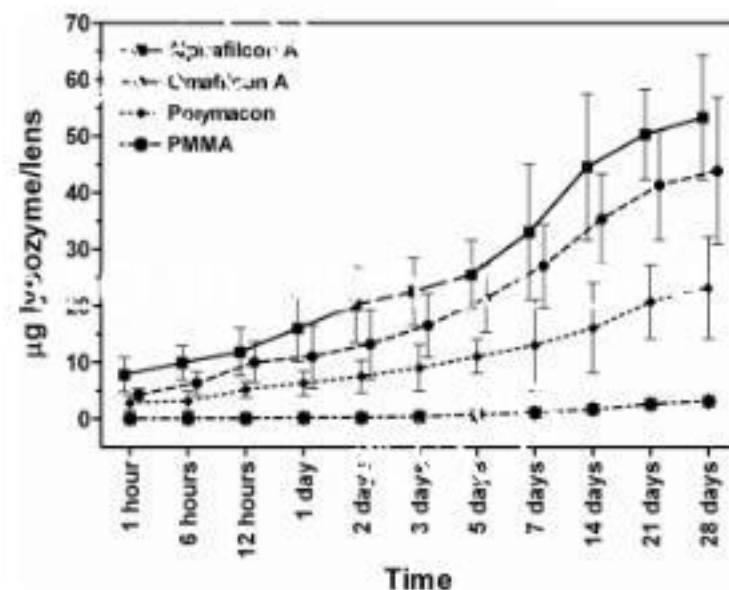


FIGURE 1 Comparison of the kinetics of lysozyme deposition (mean \pm SD) on PMMA, alphafilcon A (HEMA + PC), osmacon A (HEMA + PC), and polymacon (HEMA) lens materials (n = 4).

Benefits of daily disposable contact lenses

Lower incidence of infiltrative events compared to reusable lenses

Microbial keratitis: same incidence but less pronounced severity

Risk factors for the DD lenses group

- exceeding the lens renewal period (OR = 9.16)
- occasionally wearing CL when sleeping (OR = 15.83)



Chalmers RL, et al. Rates of adverse events with hydrogel and silicone hydrogel daily disposable lenses in a large postmarket surveillance registry: the TEMPO Registry. *Invest Ophthalmol Vis Sci.* 2015;56:654-63.

Stapleton F et al. The incidence of Contact lens-related Microbial Keratitis in Australia. Population based surveillance study. *Ophthalmology.* 2008;115:1647-1654

Sauer A et al. Contact Lenses and Infectious Keratitis: From a Case-Control Study to a Computation of the Risk for Wearers. *Cornea.* 2020 Jun;39(6):769-774.



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