Polymer Fundamentals for Coatings

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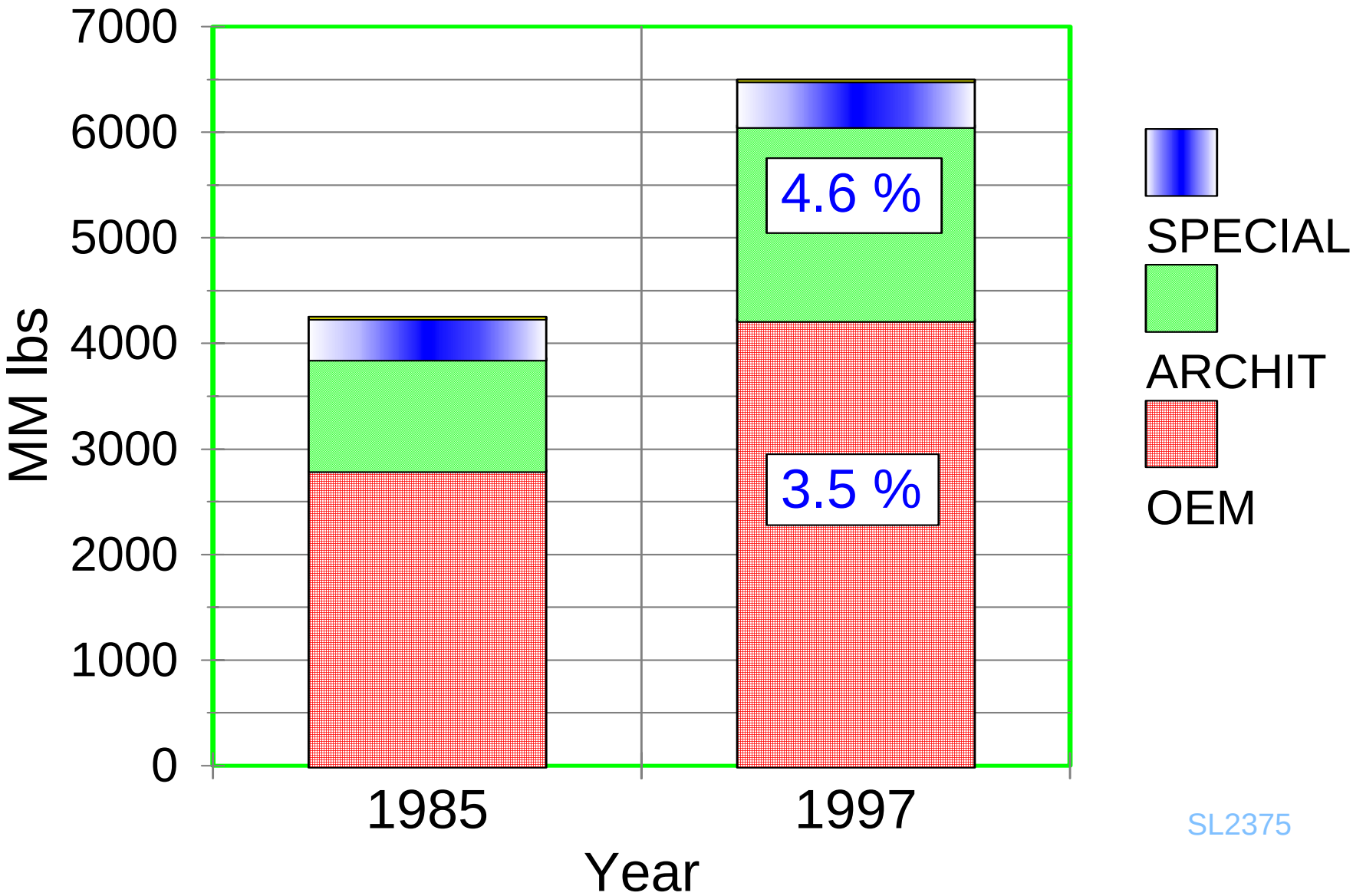
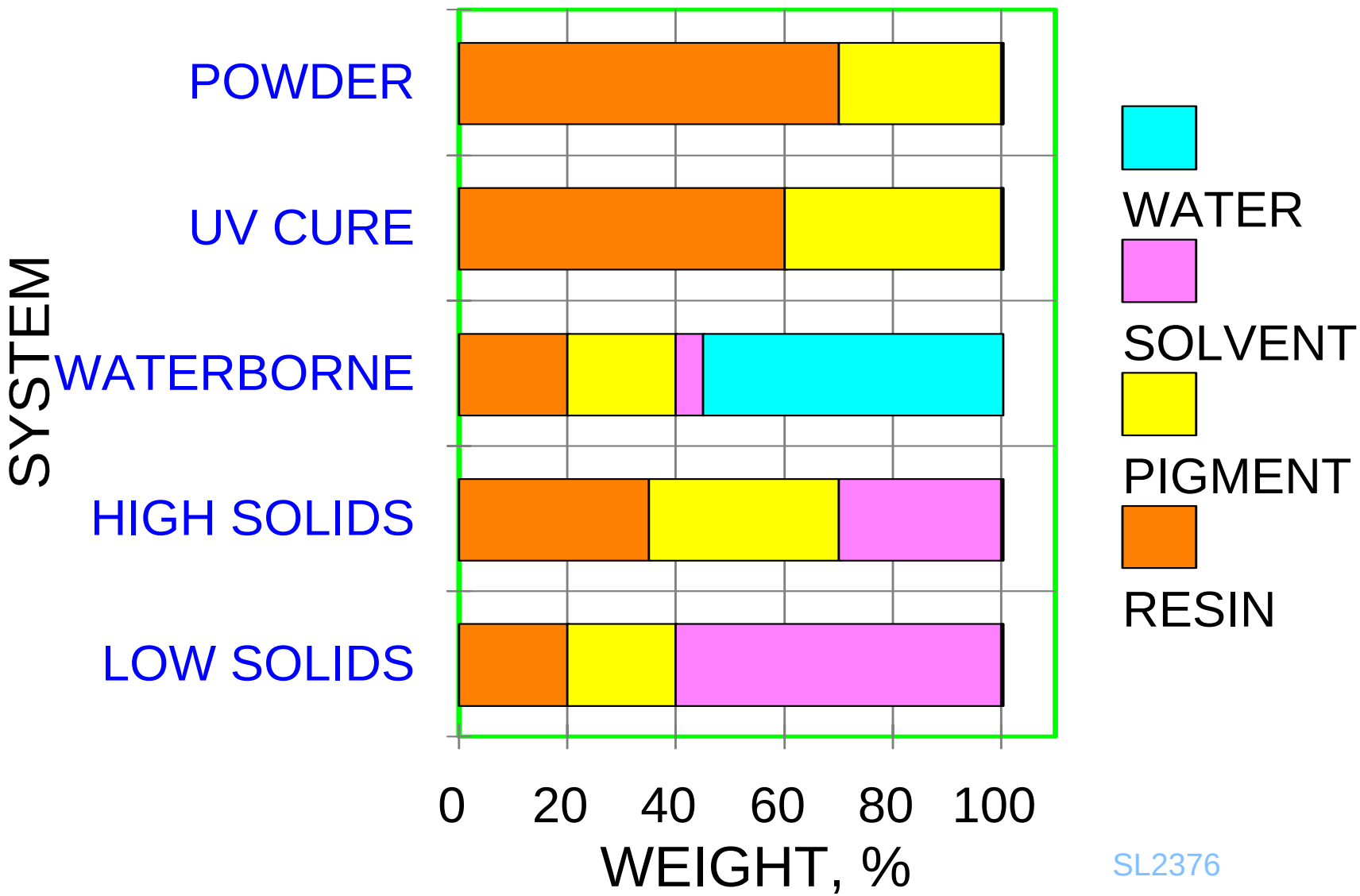
RESIN CONSUMPTION

1985 - 1997



SL2375

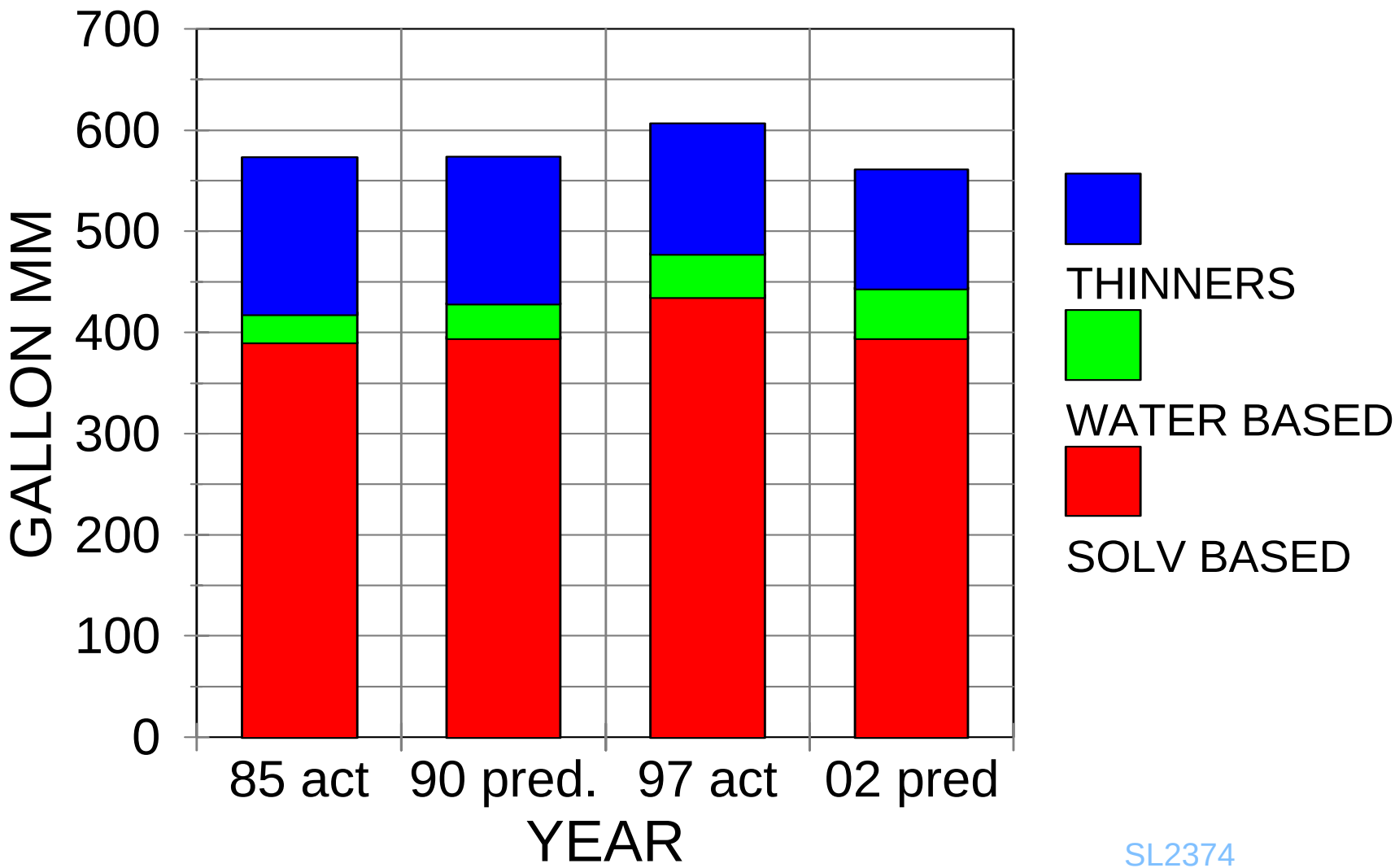
COATING FORMULATIONS



SL2376

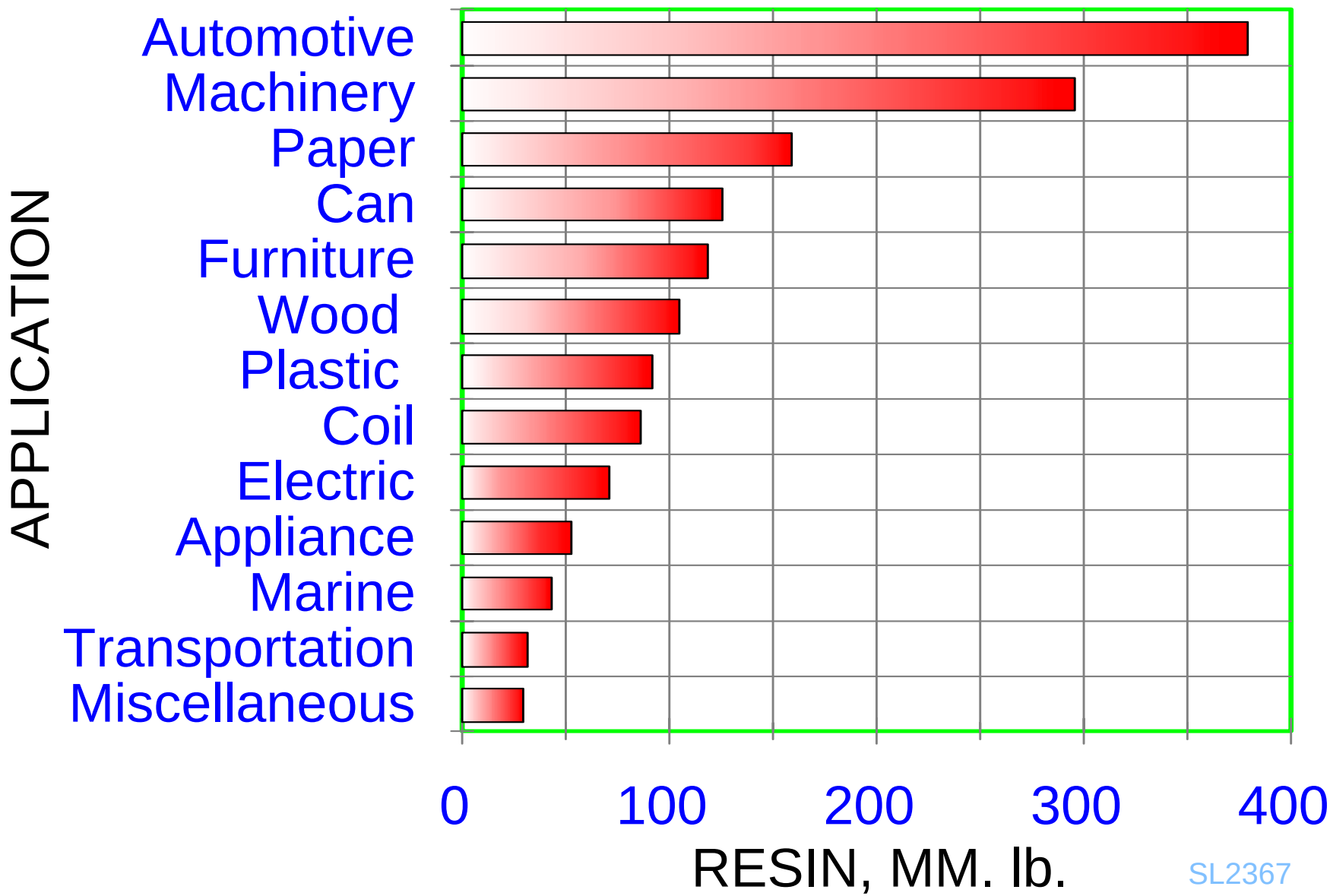
SOLVENT CONSUMPTION

ACTUAL & PREDICTED



SL2374

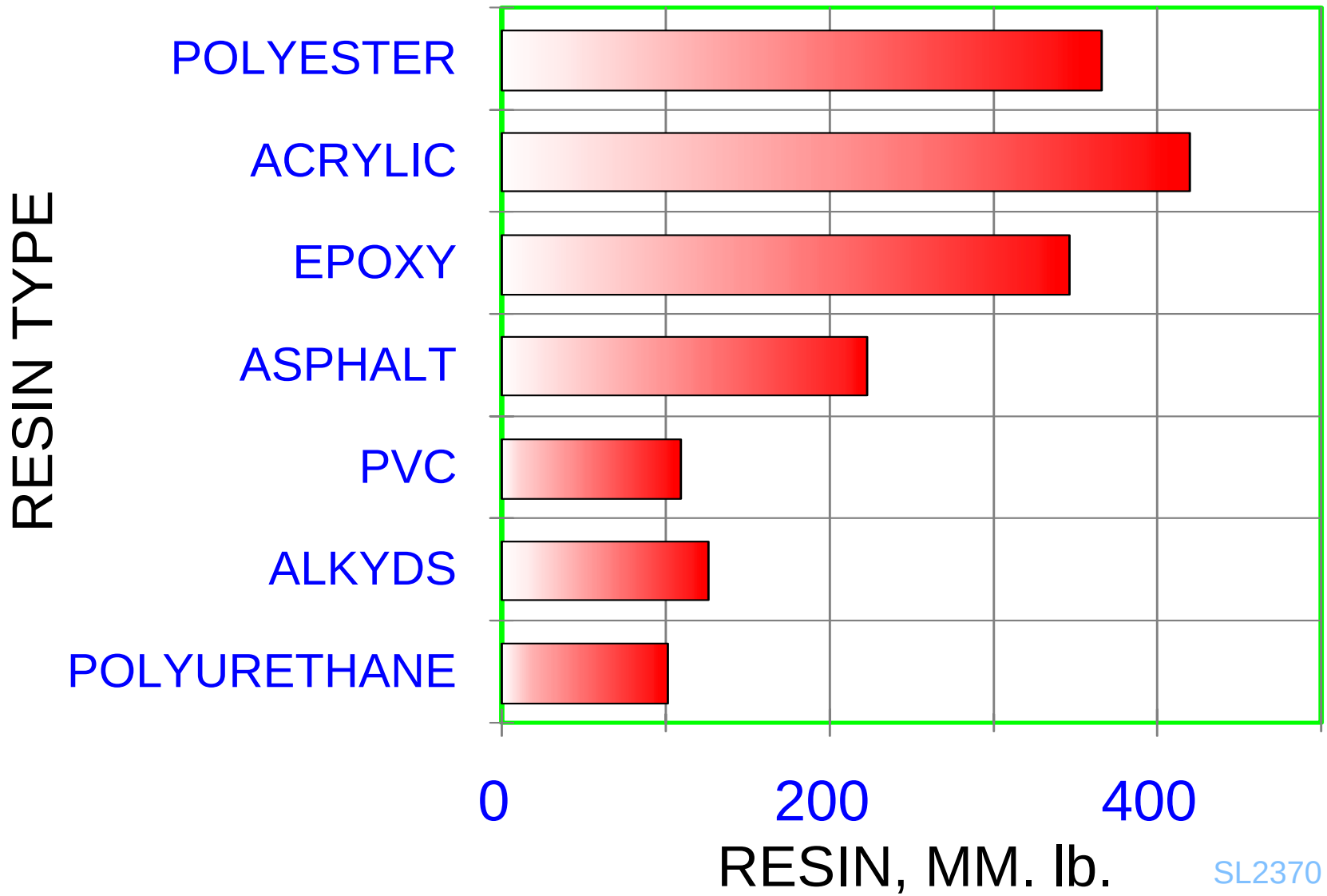
OEM RESINS LBS. 2002



SL2367

RESINS OEM 2002

MM. LB



SL2370

RESINS OEM 2002

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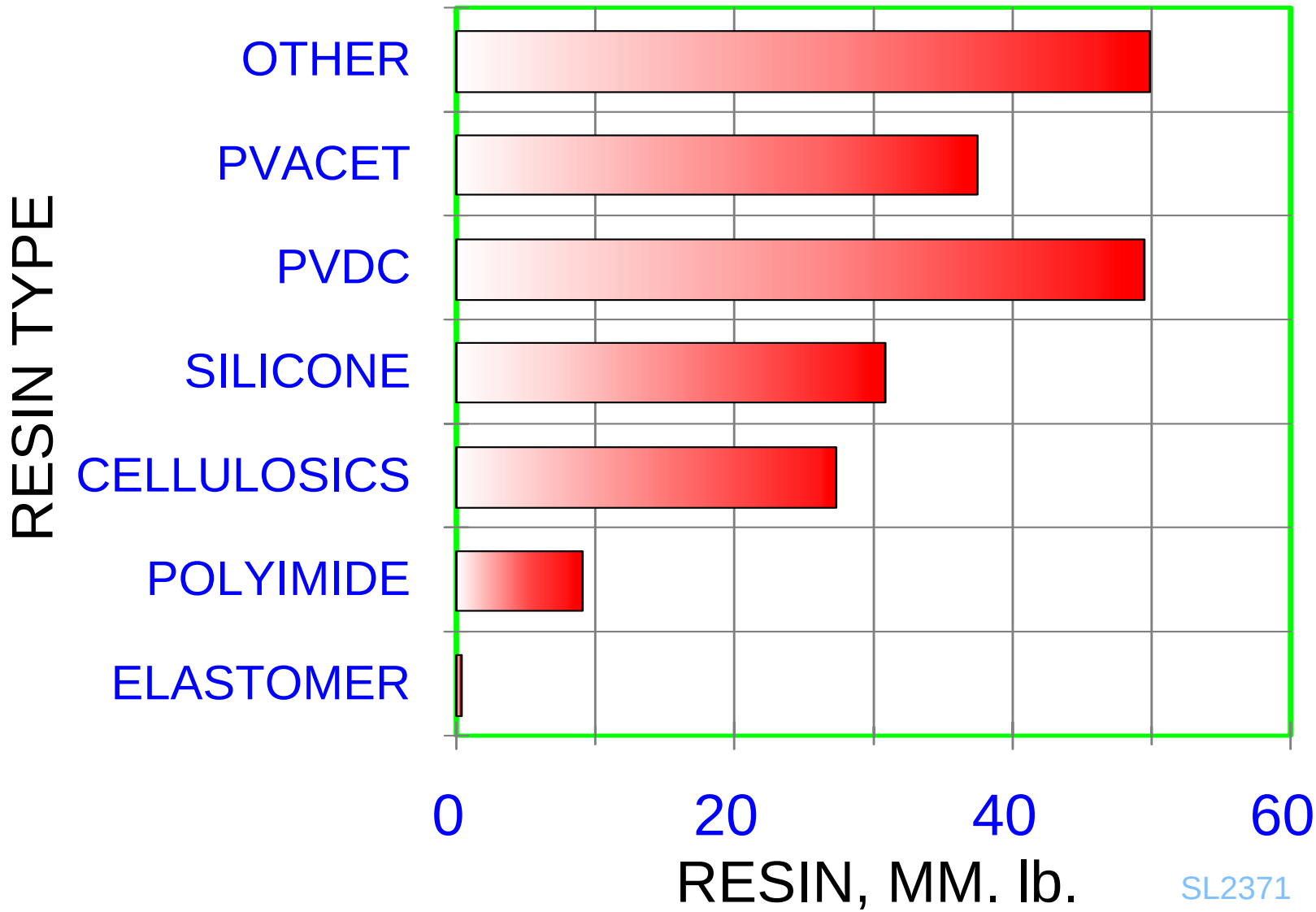
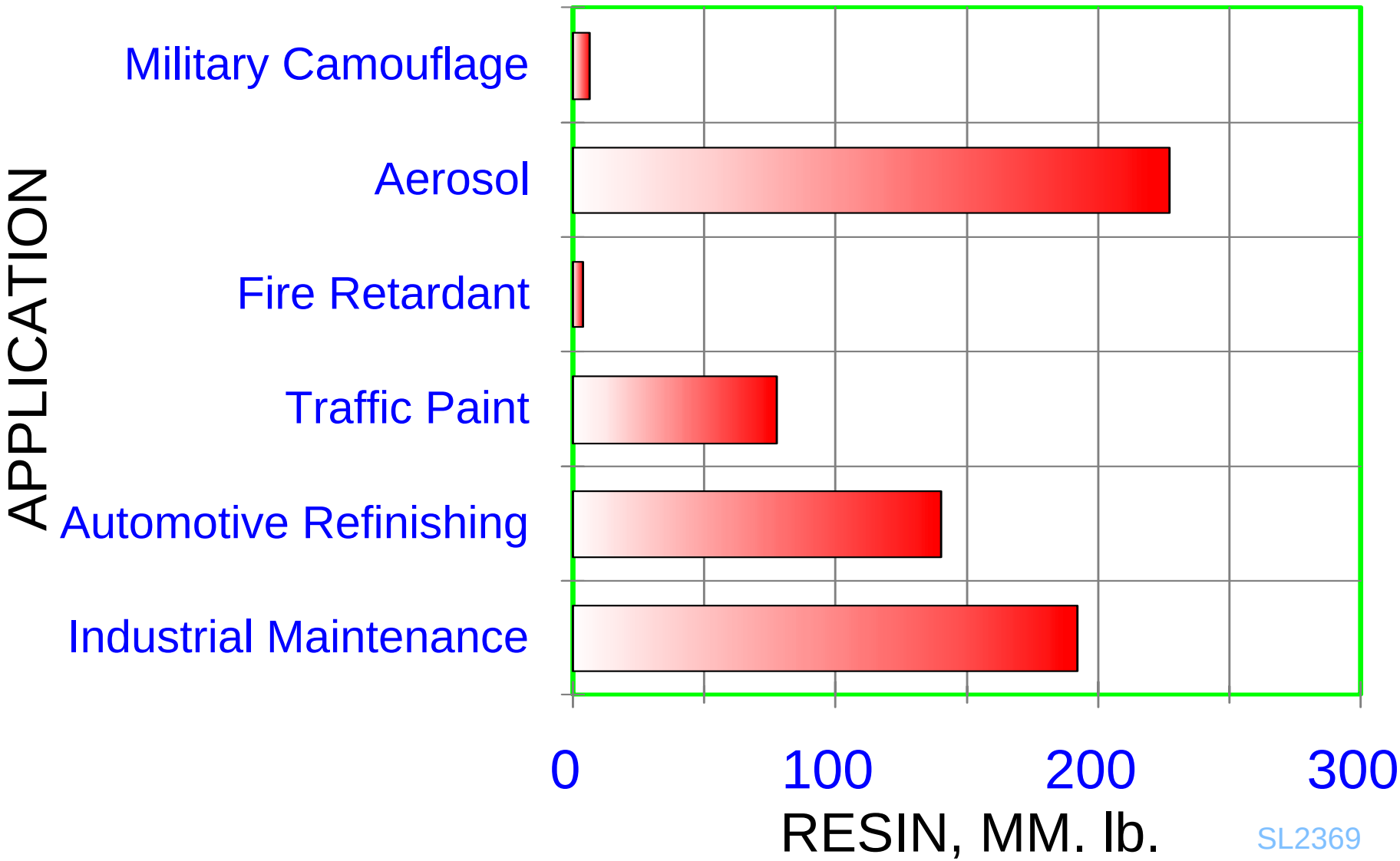


SL2371

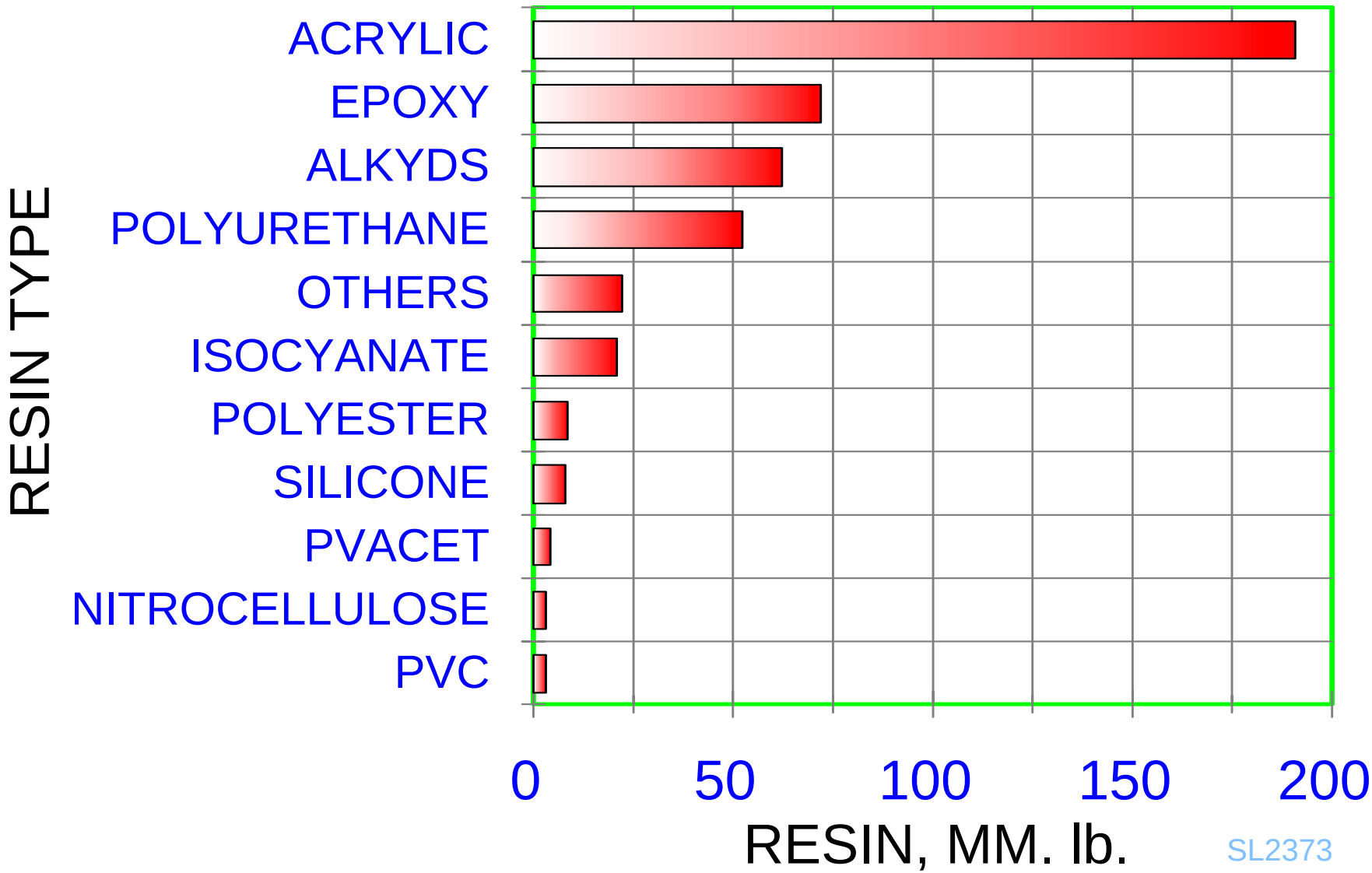
Specialty Coatings 2002

RESINS MM. LB



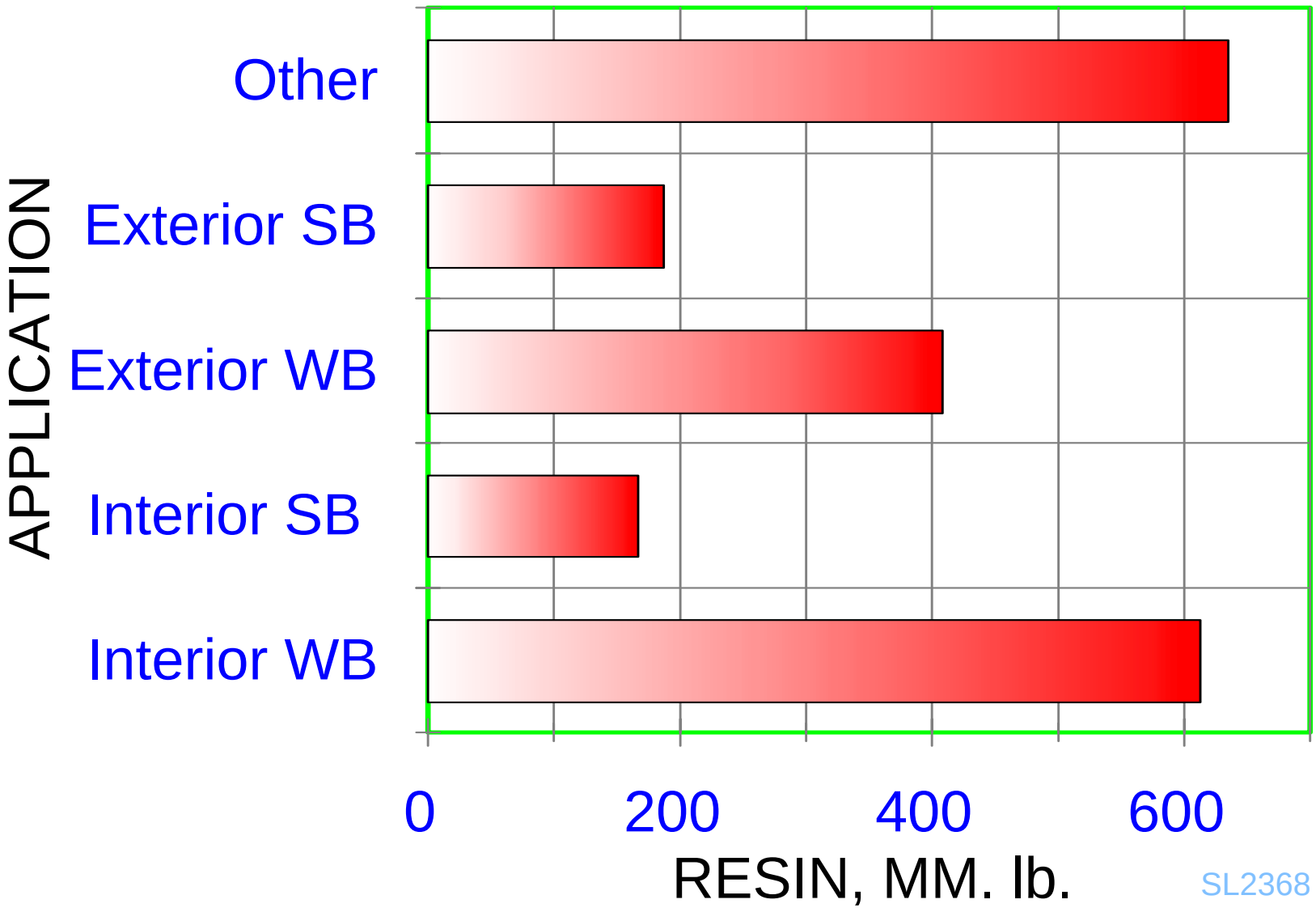
RESINS SPECIALTY 2002

MM. LB



ARCHITECTURAL 2002

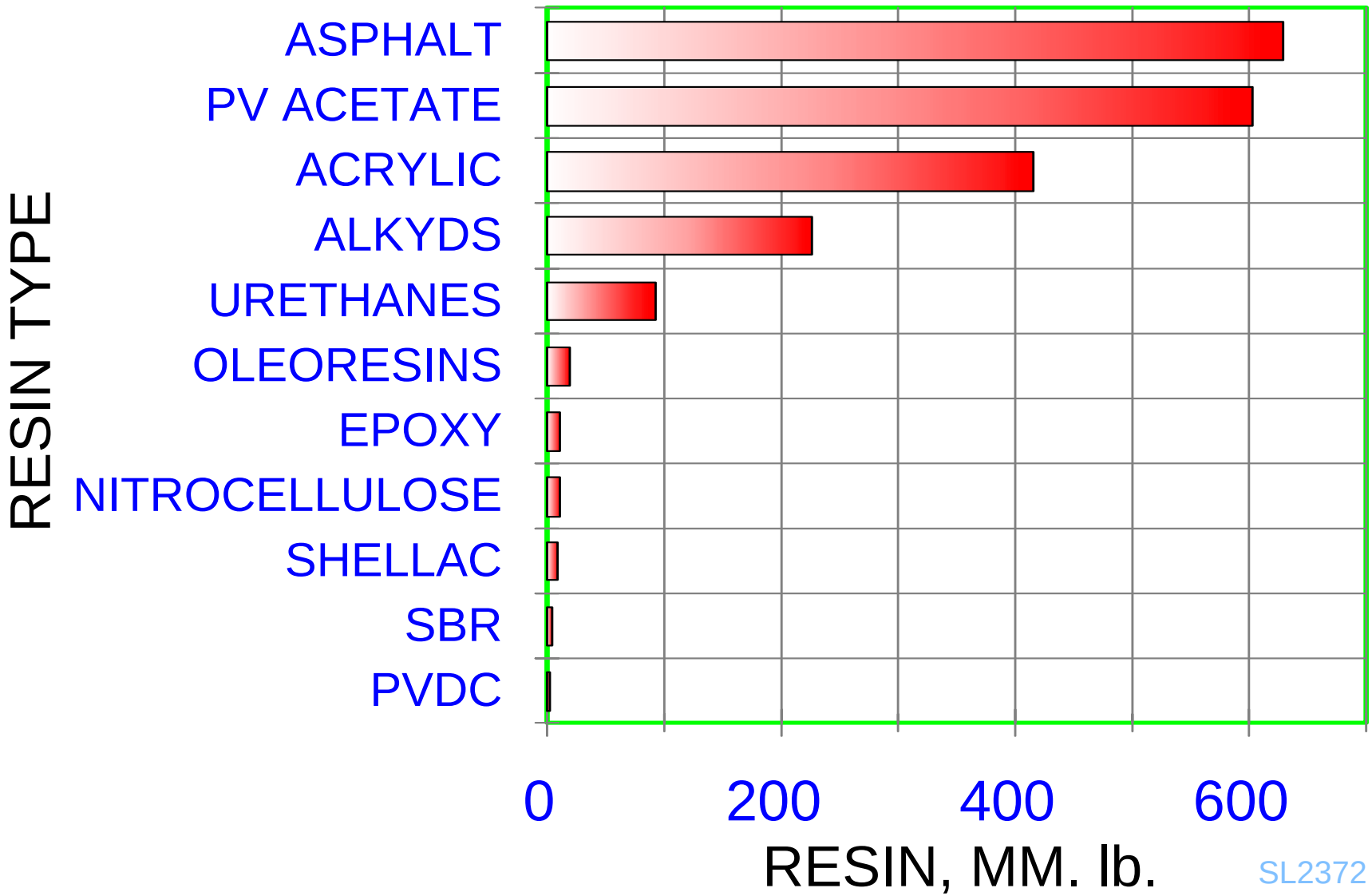
RESINS MM. LB



SL2368

RESINS ARCHITECTURAL 2002

MM. LB



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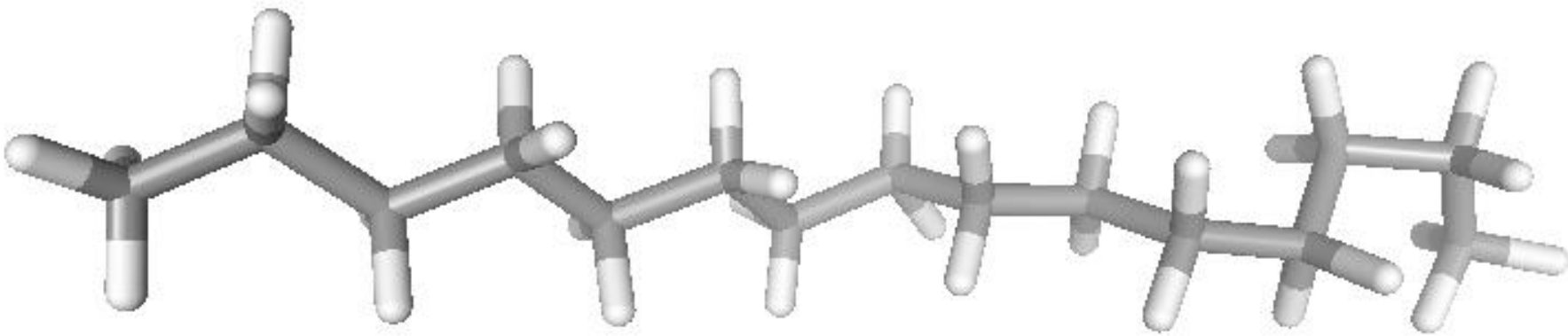
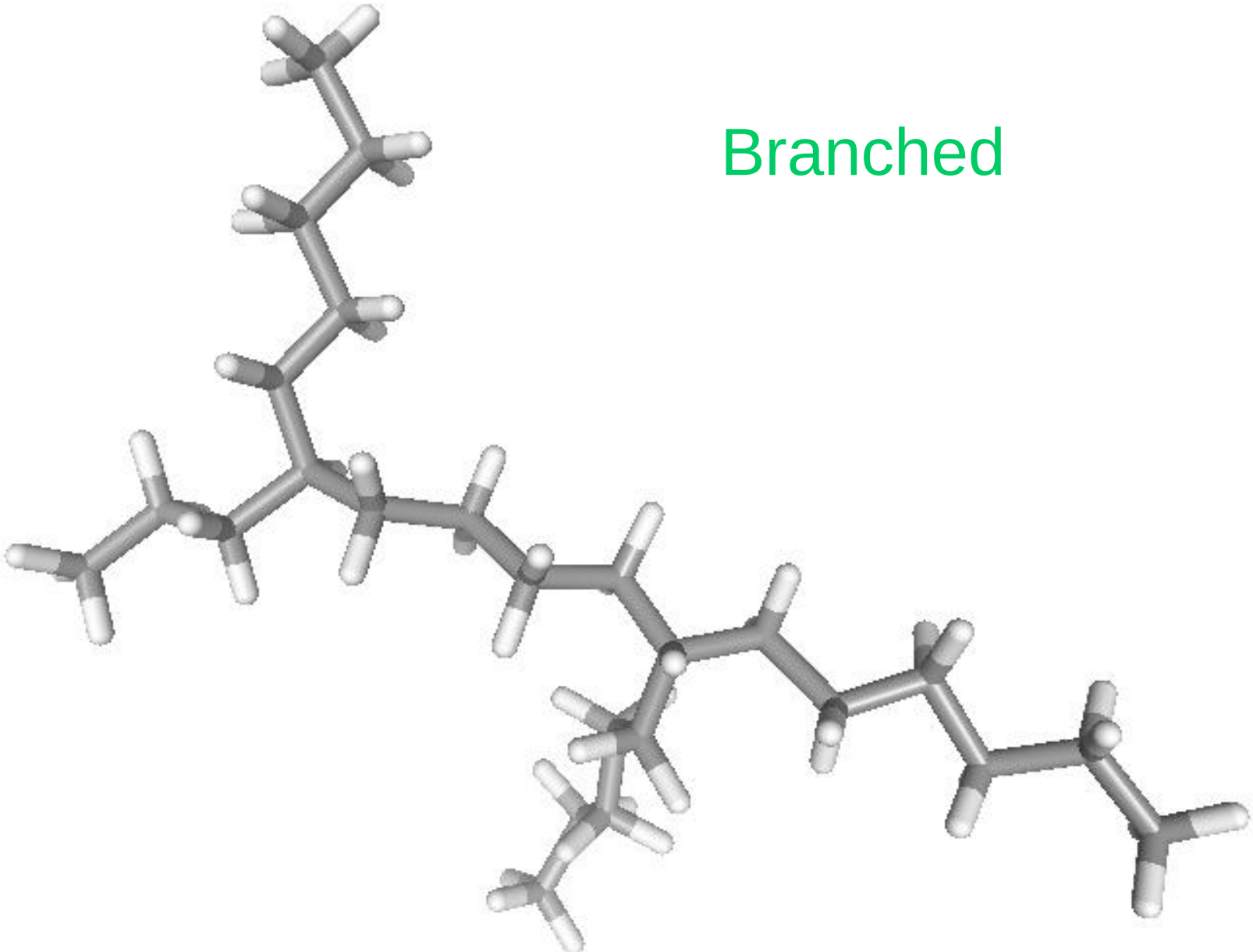
Architecture

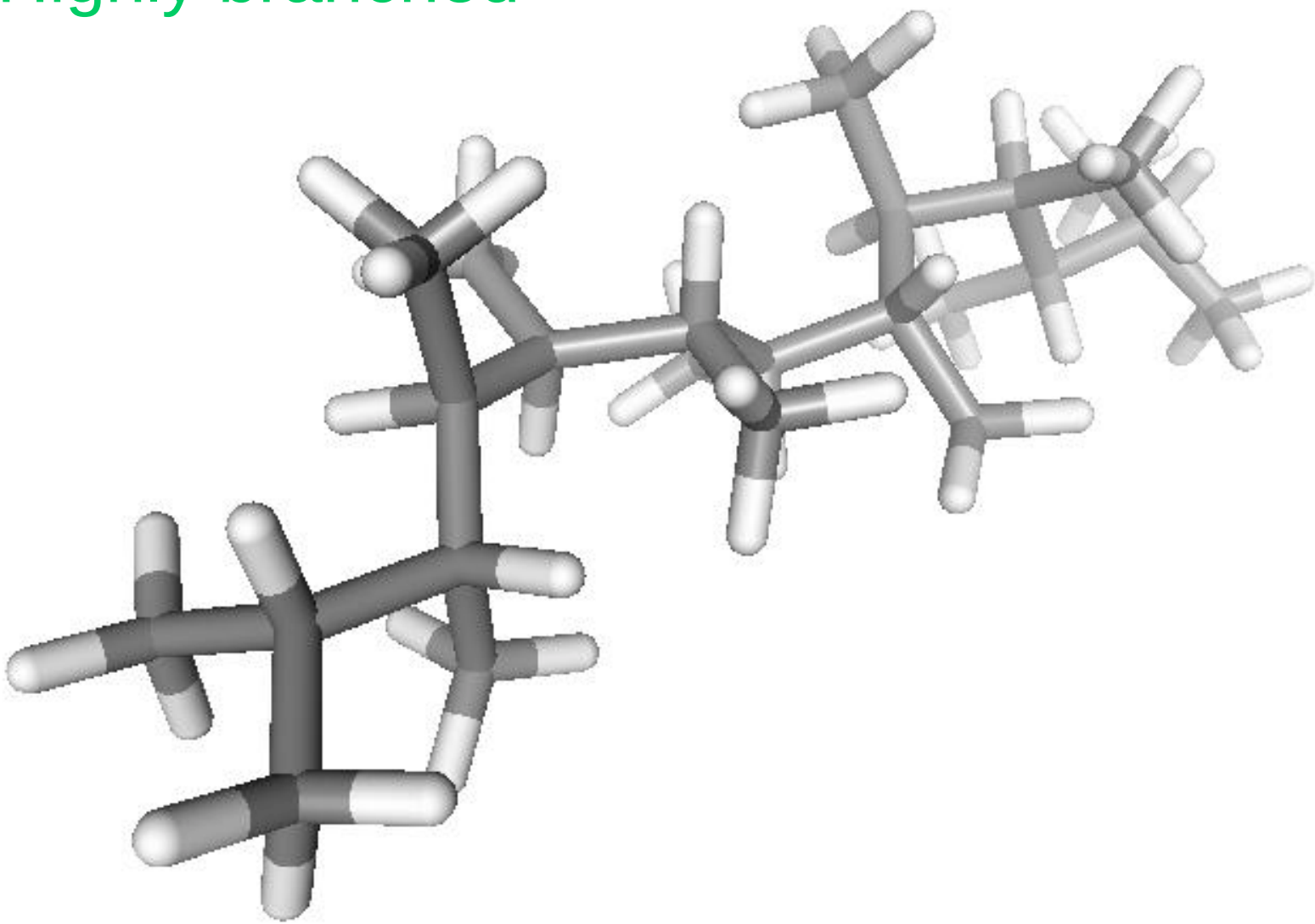
Linear



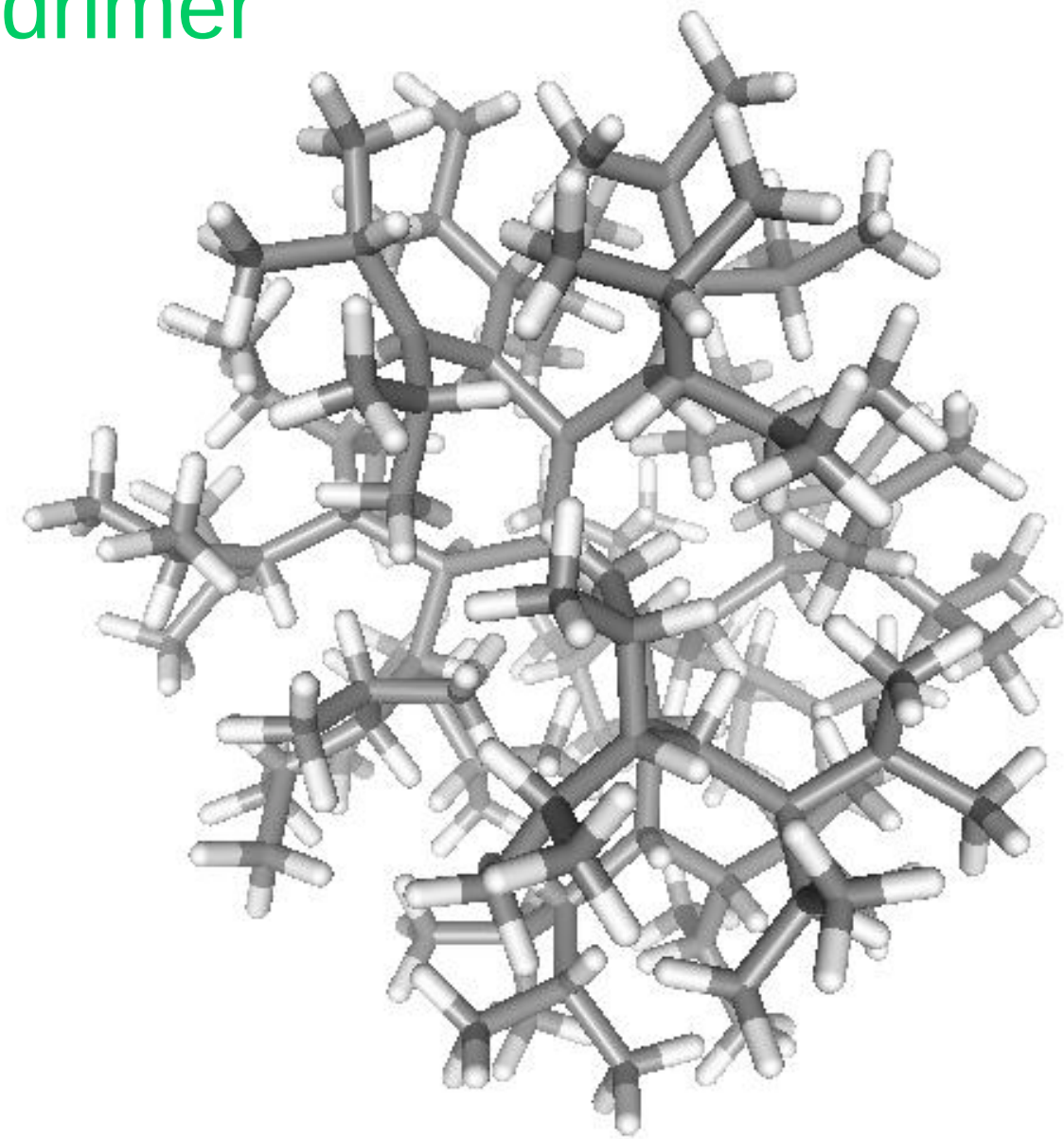


Branched

Highly branched

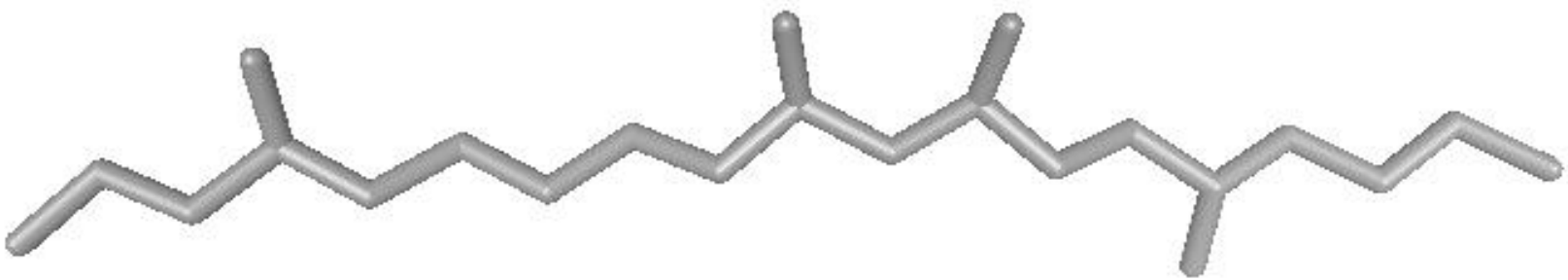


Dendrimer



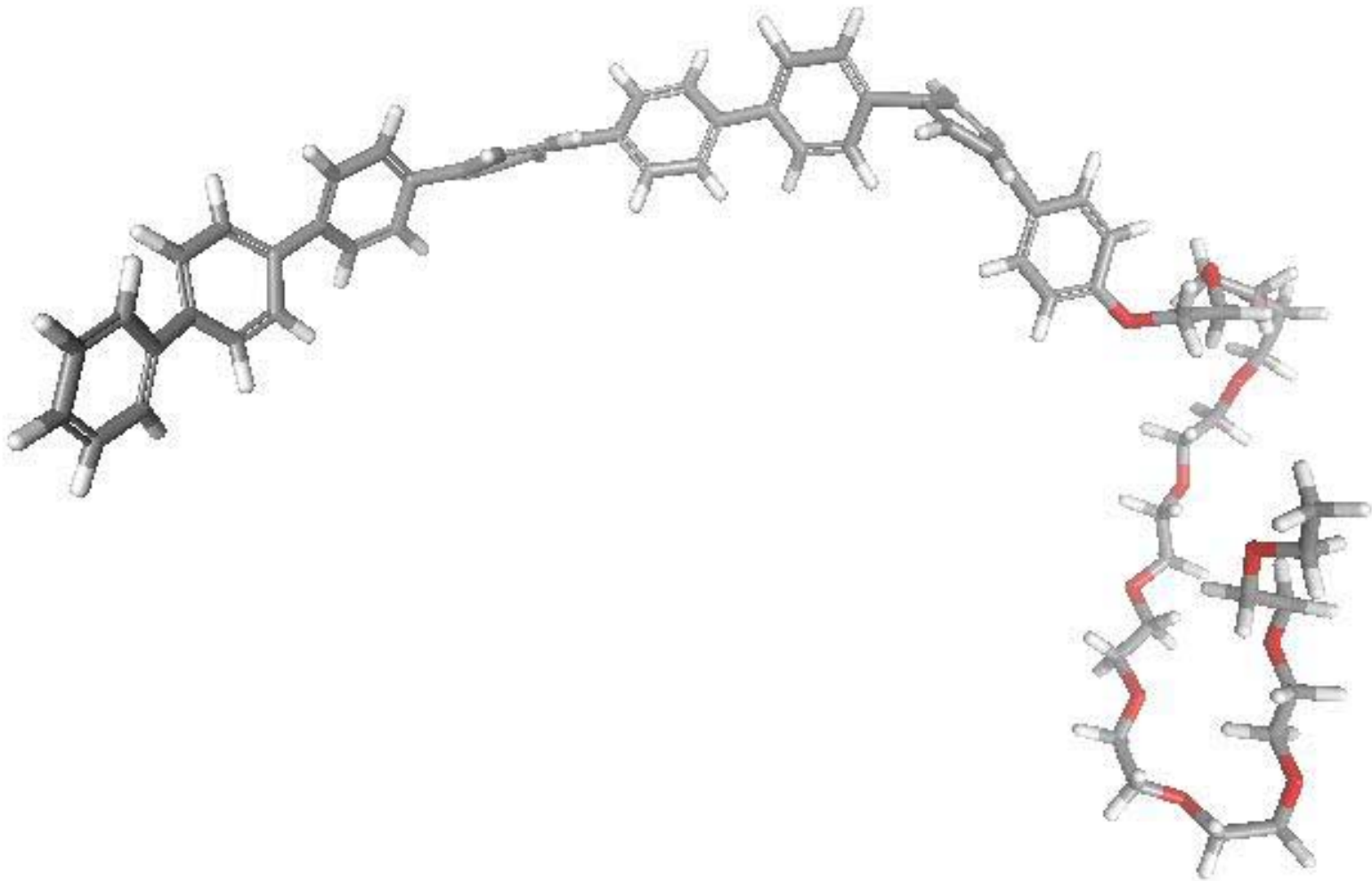
Random Copolymer

Flexible

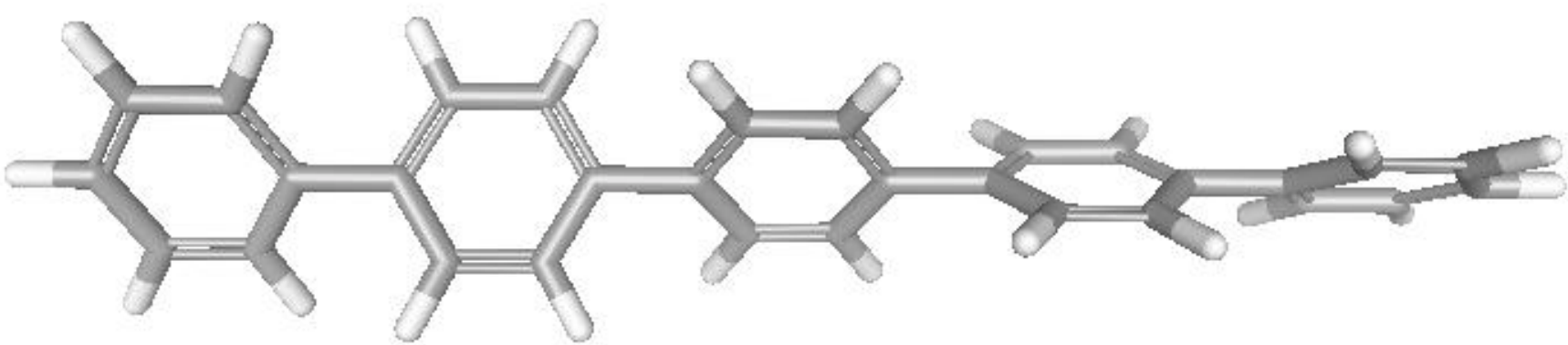


Block

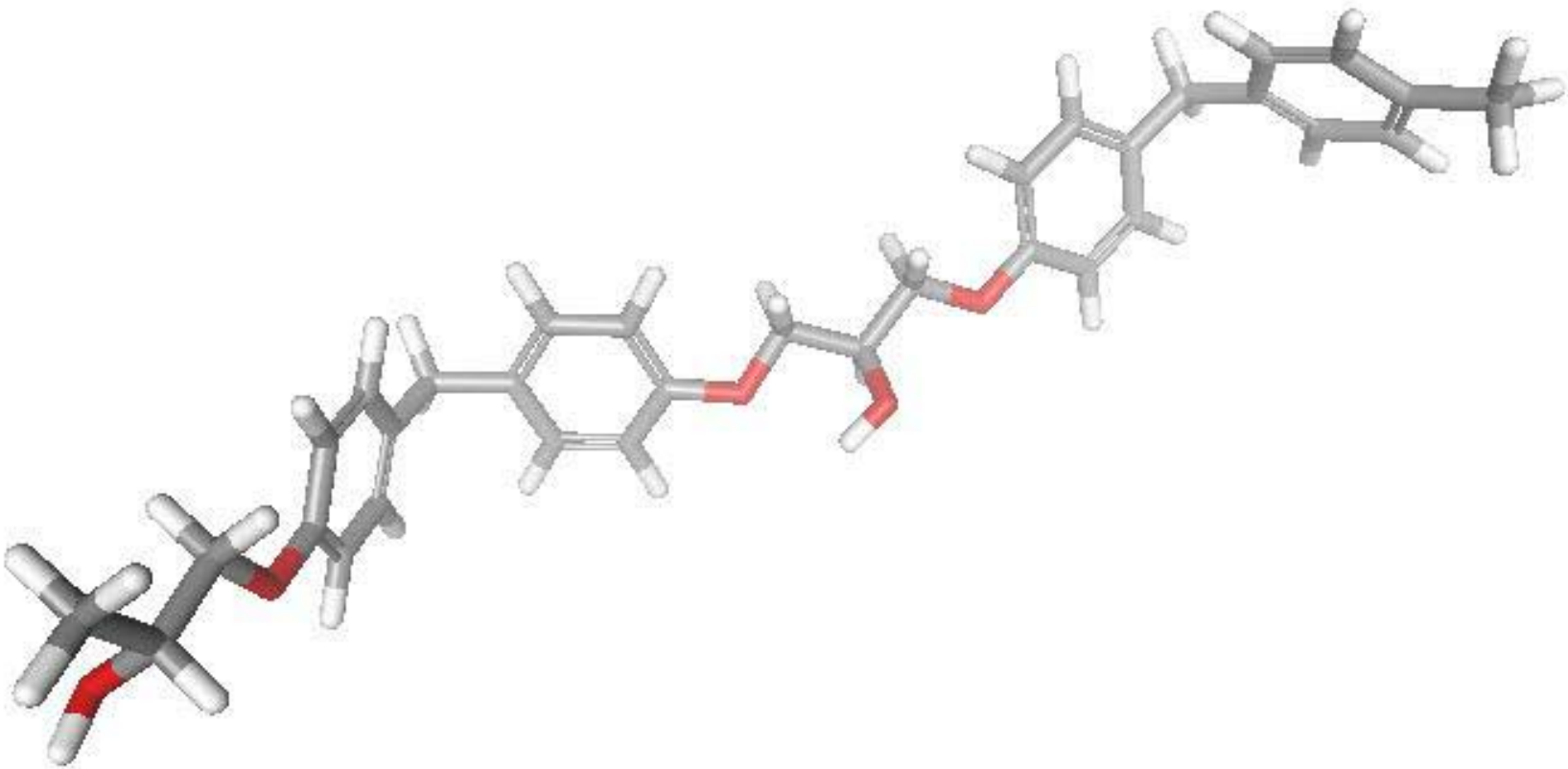
Rigid - flexible



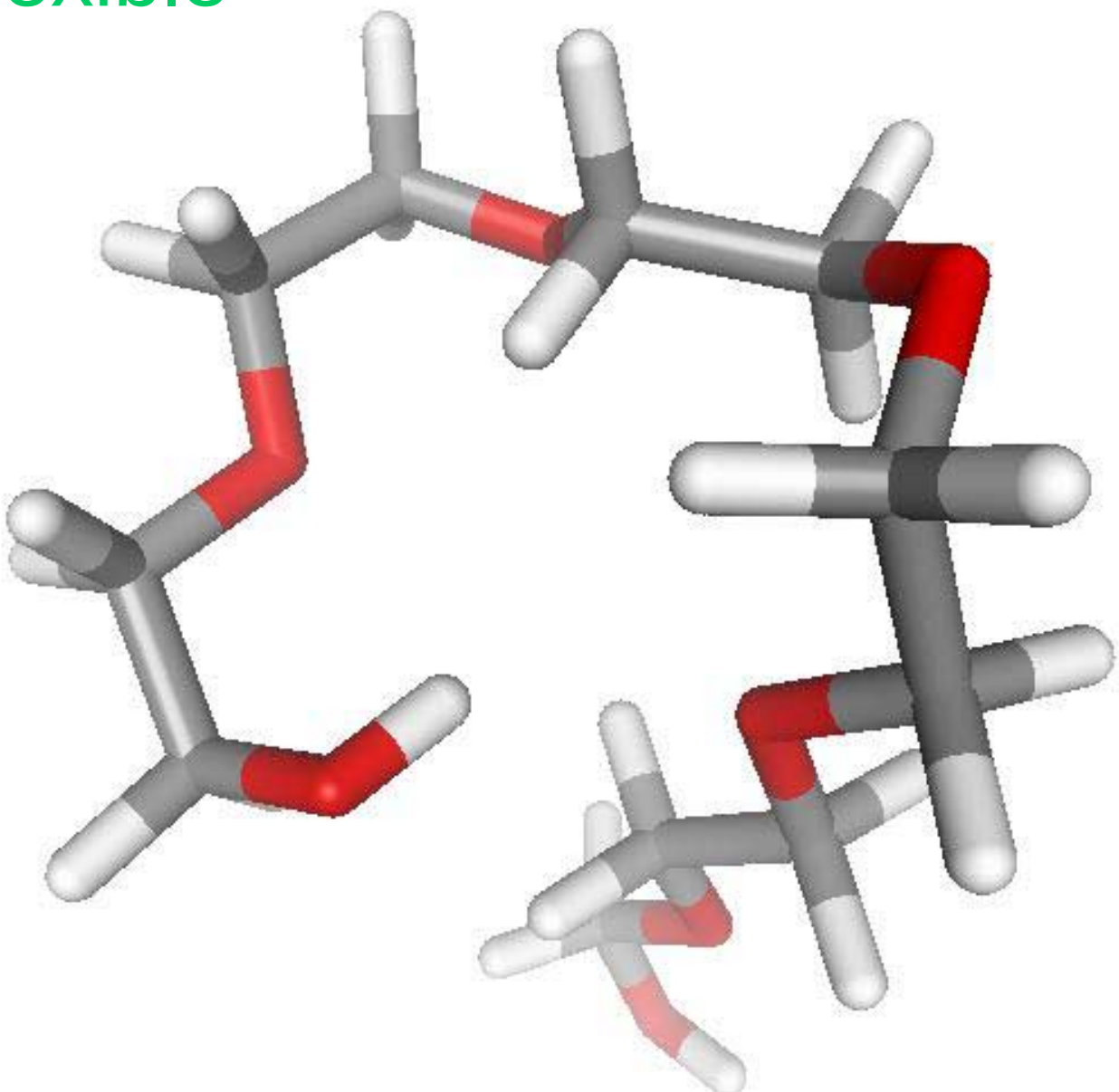
Homo polymer
Rigid



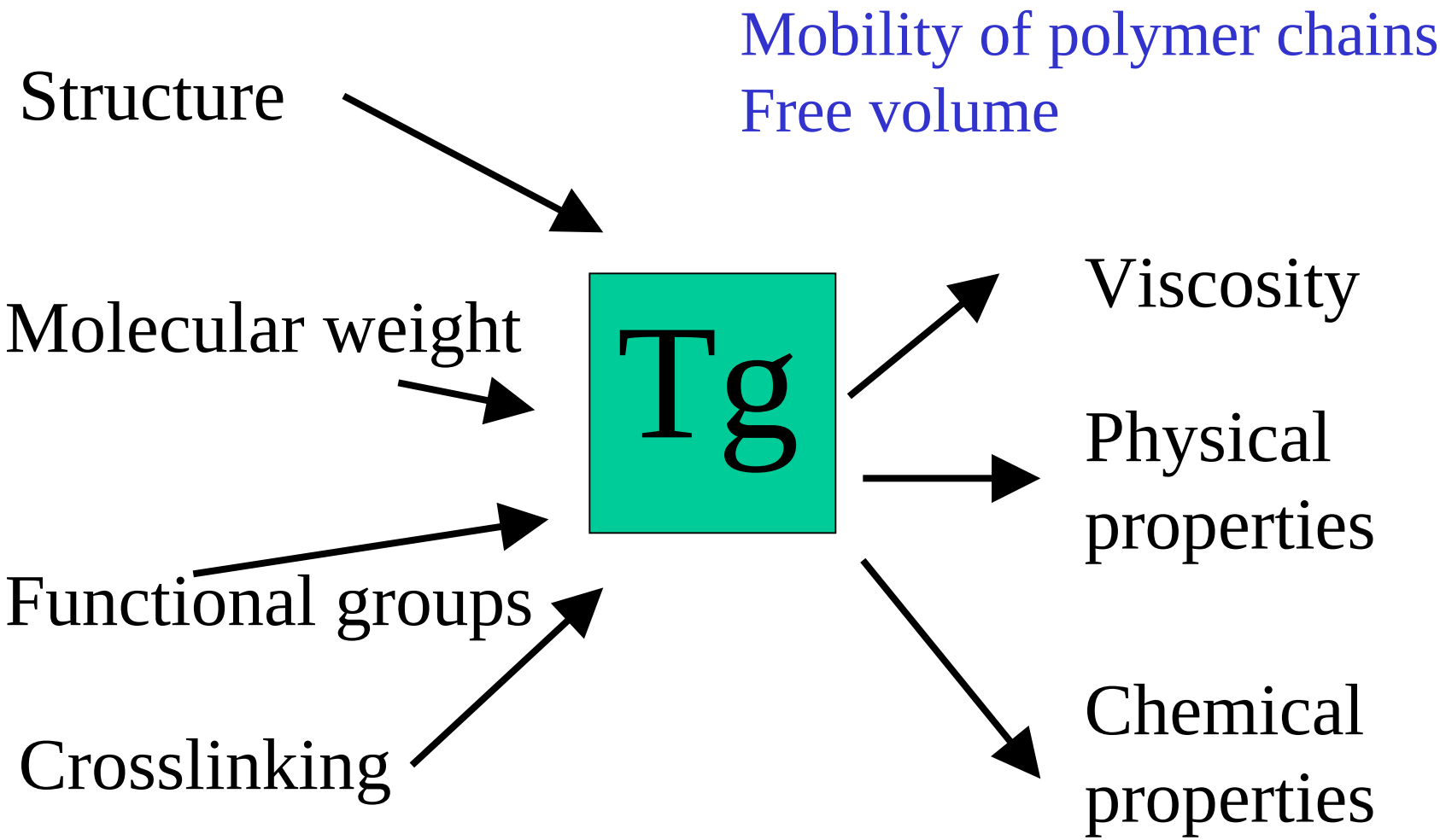
Alternating



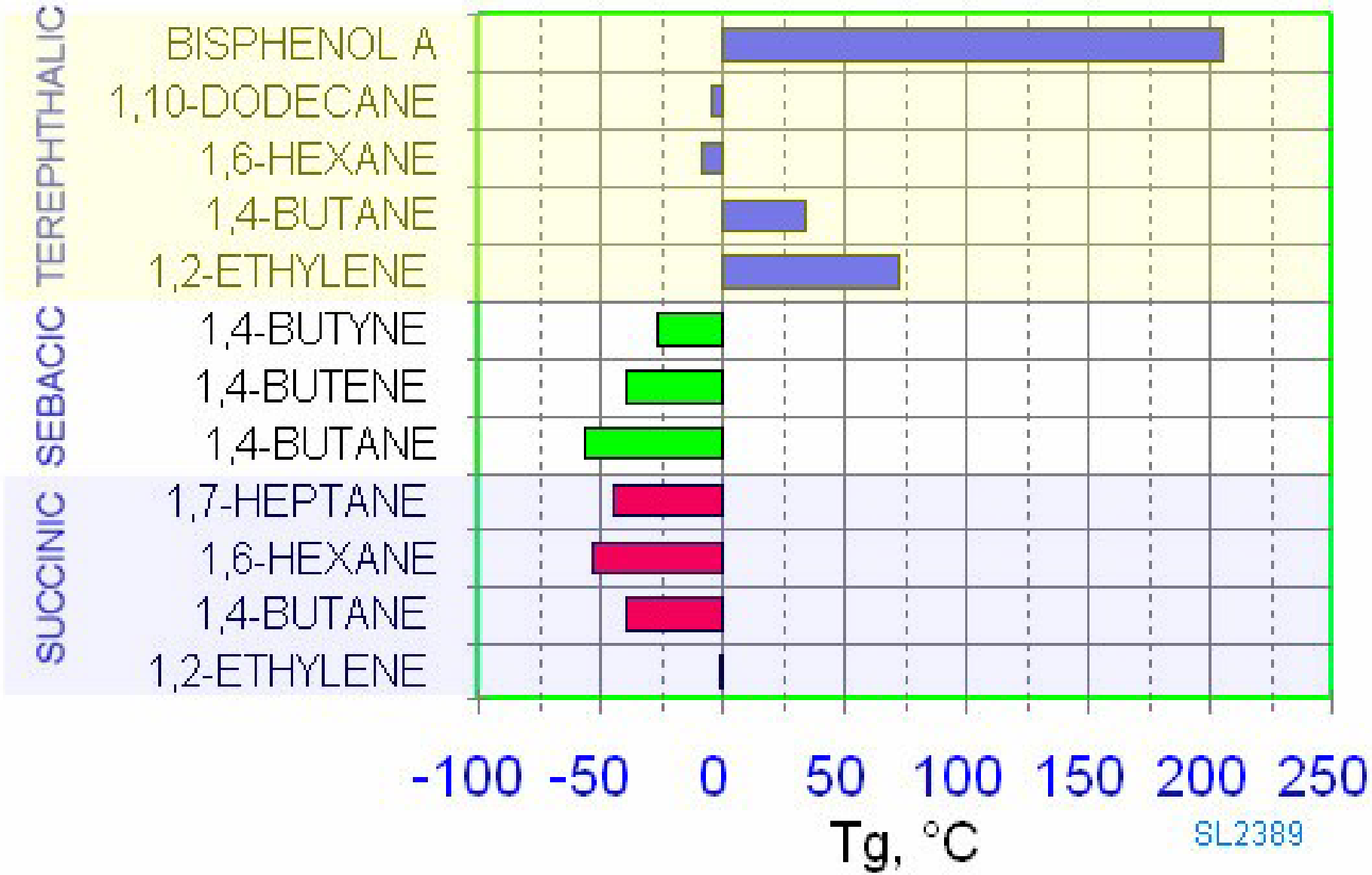
Flexible



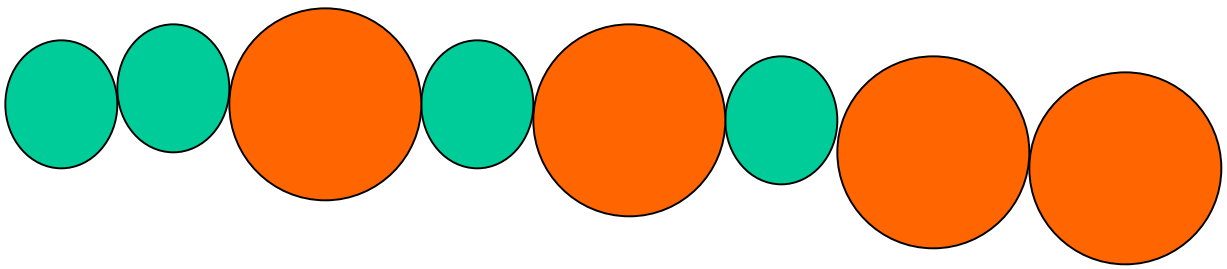
Glass Transition Temperature



Tg of POLYESTER



Tg of copolymer



$$\frac{1}{Tg} = \frac{W_1}{Tg_1} + \frac{W_2}{Tg_2} + \frac{W_n}{Tg_n}$$

W_n = weight fraction

WLF Equation

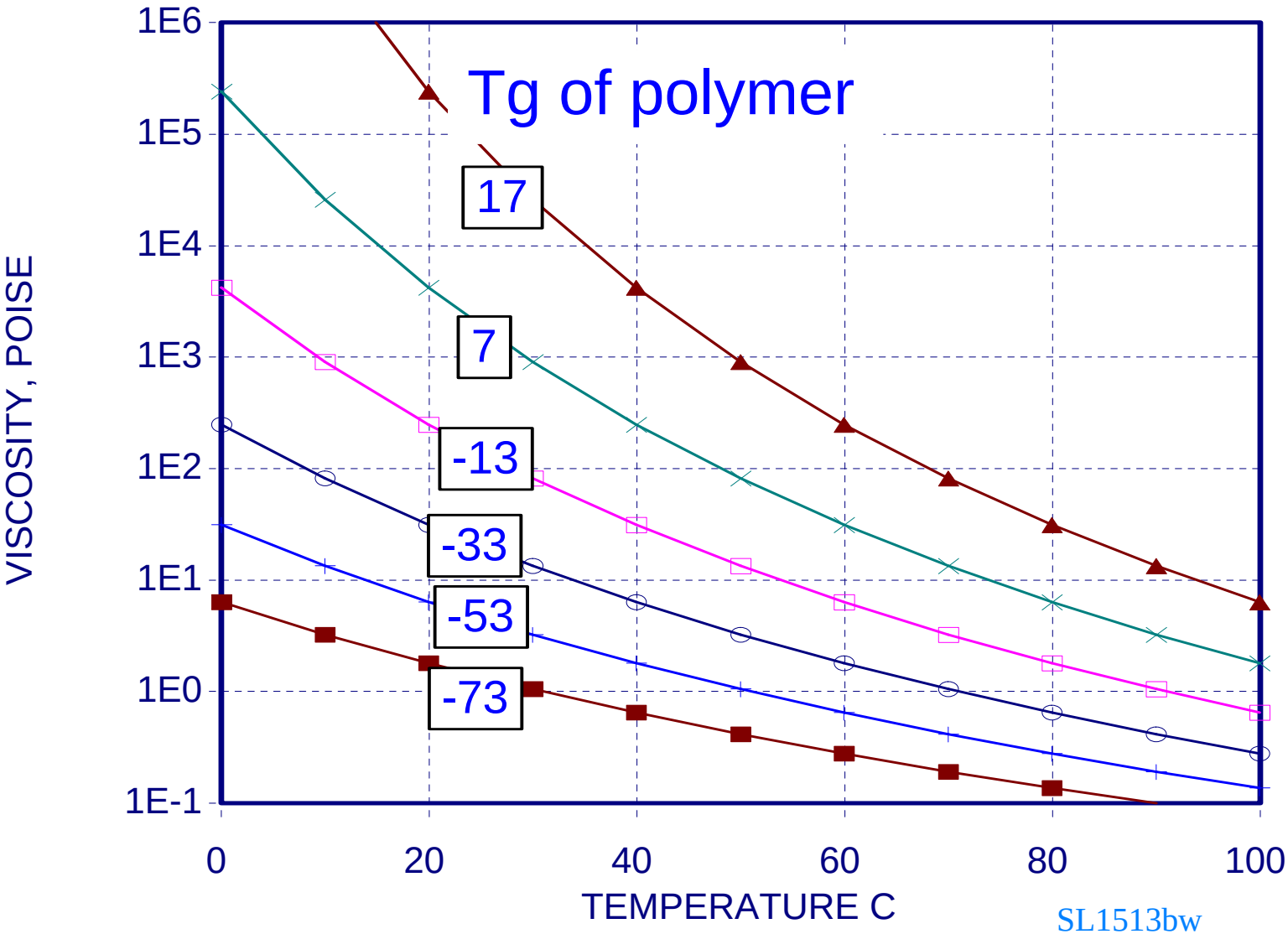
$$\log \eta_T = 13 - \frac{17.44(T-Tg)}{51.6+(T-Tg)}$$

η = Poise T, Tg = °K or °C

L.E.Nielsen, Polymer Rheology, Marcel Dekker, 1977, pp33,74,133

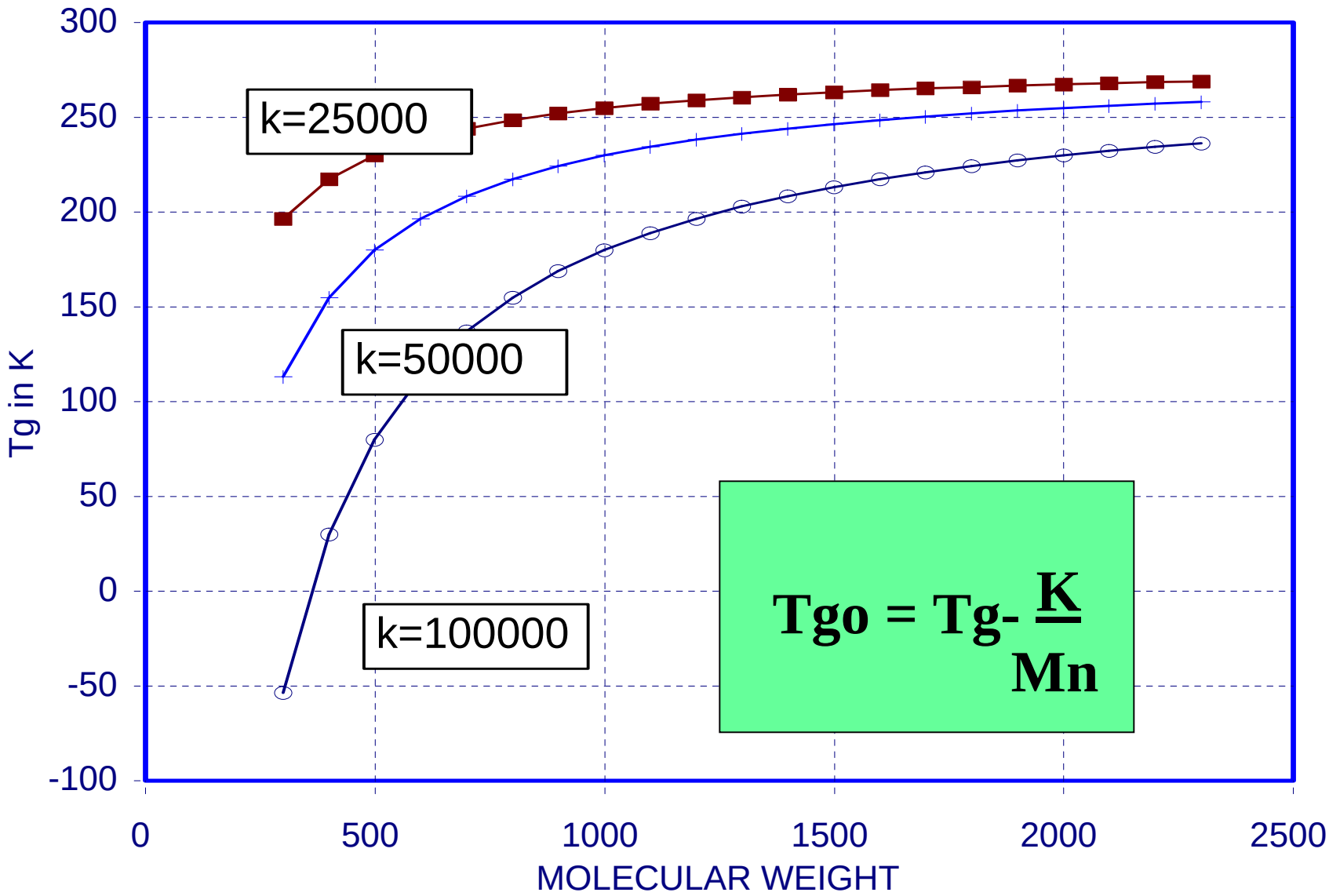
VISCOSITY as a FUNCTION OF Tg

WILLIAMS,LANDEL,FERRY EQUATION

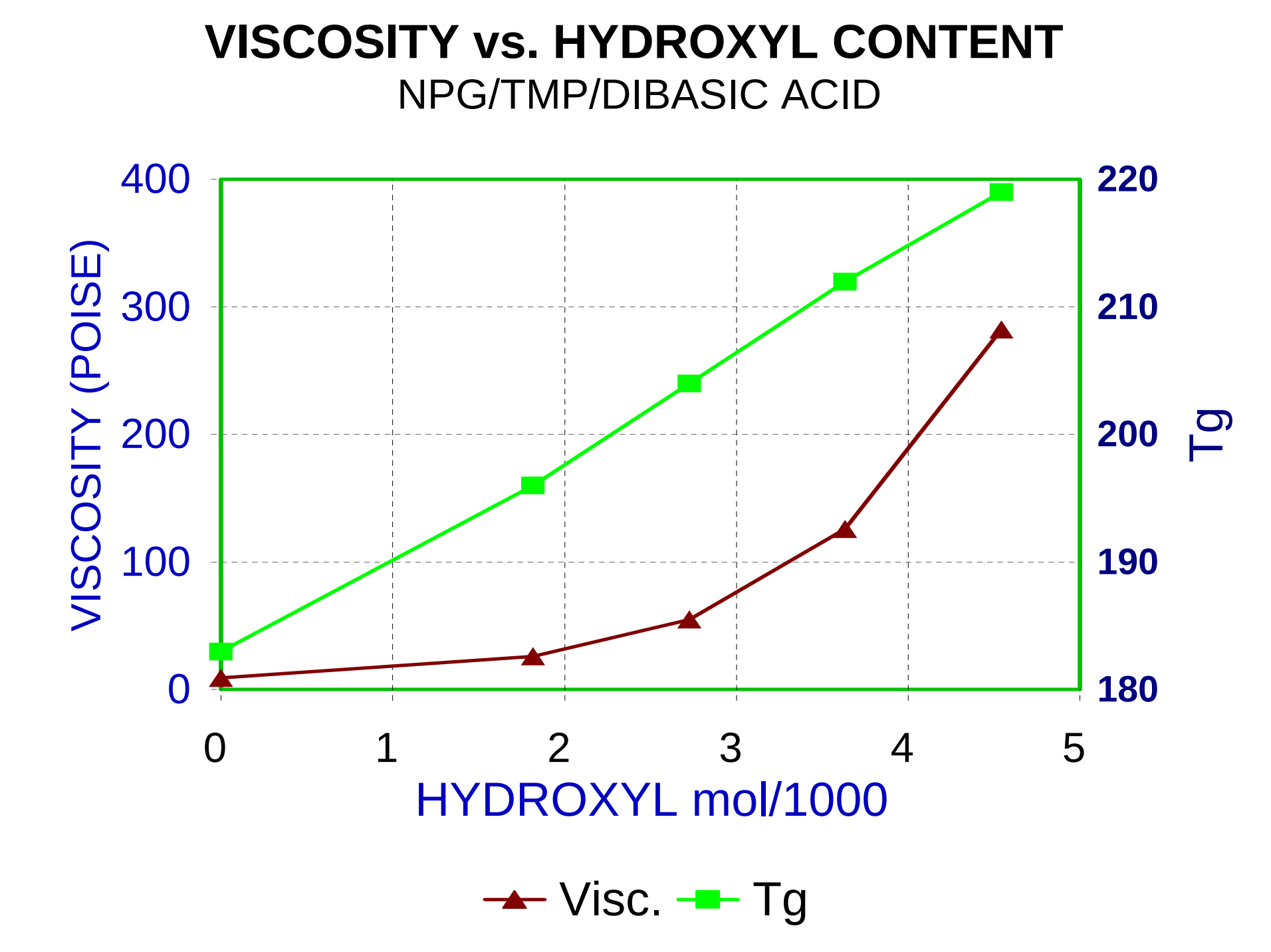


SL1513bw

Tg vs MOLECULAR WEIGHT
OF OLIGOMERS



SL1504

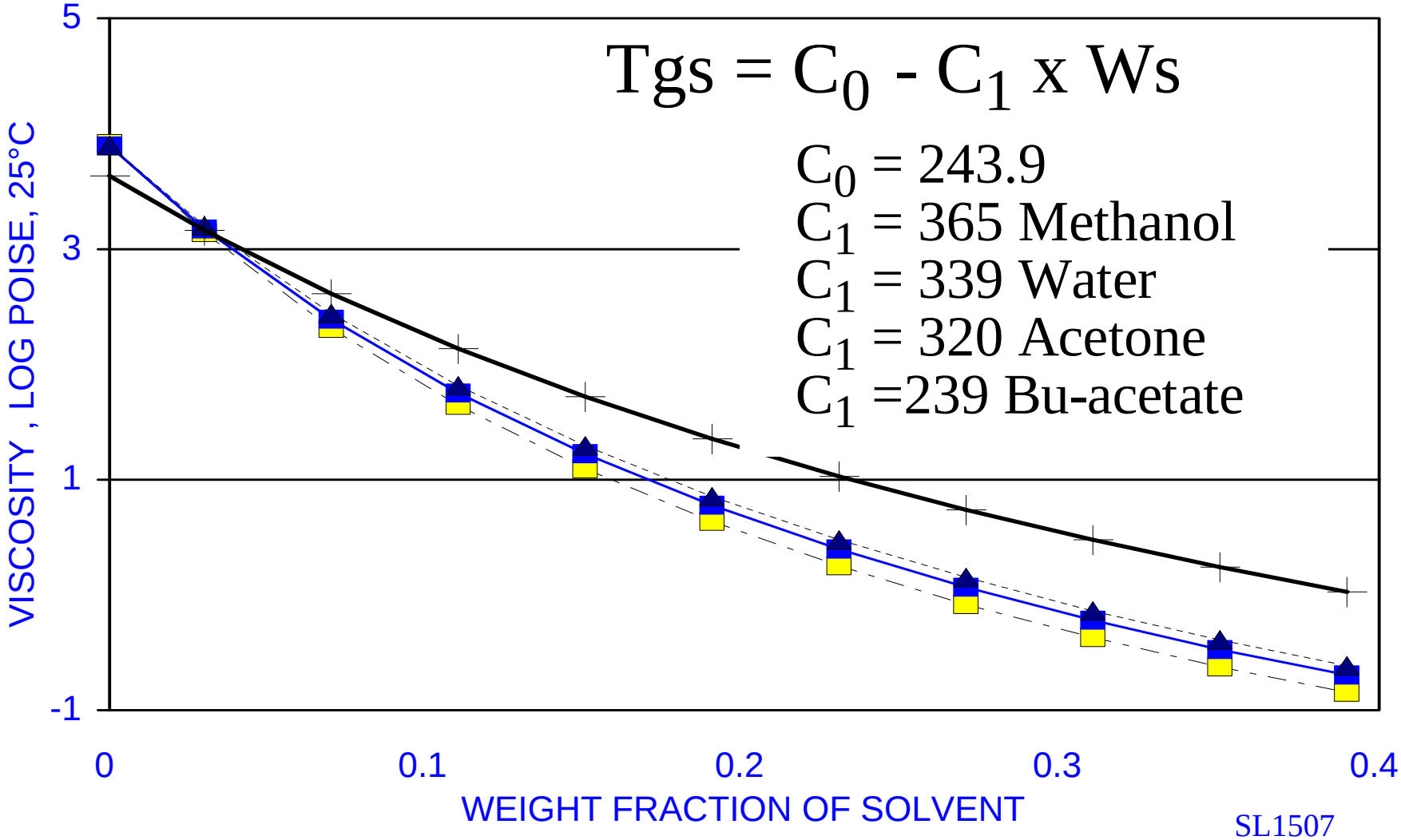

VISCOSITY vs. HYDROXYL CONTENT
NPG/TMP/DIBASIC ACID
VISCOSITY (POISE)
400
300
200
100
0
220
210
200
190
180
Tg
0
1
2
3
4
5
HYDROXYL mol/1000
Visc.
Tg

WLF Equation

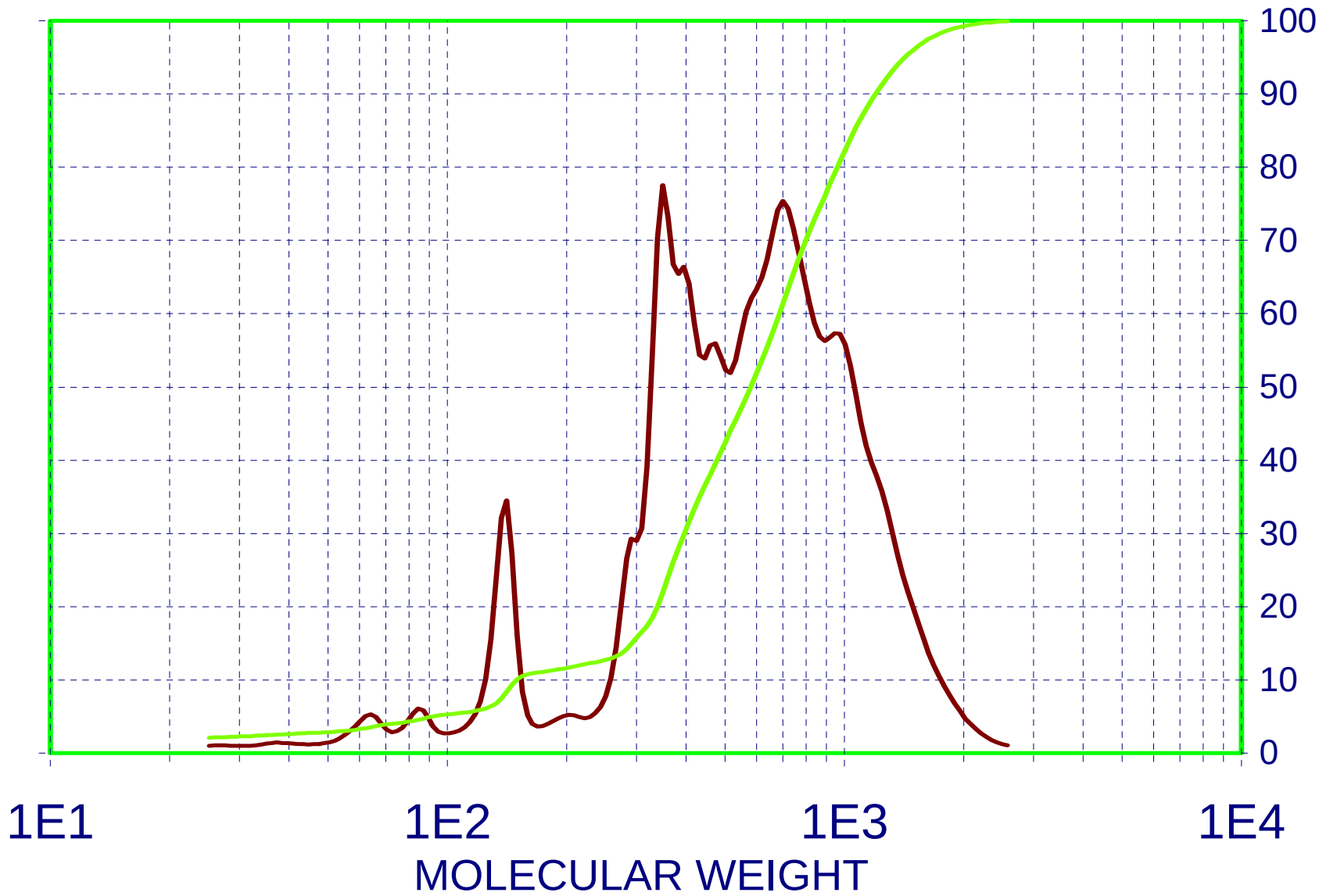
$$\log \eta_T = 13 - \frac{17.44(T-Tg)}{51.6+(T-Tg)}$$

$$Tg_s = C_o - C_1 \times W_s$$

VISCOSITY OF K-FLEX UD-320-100



Polyurethane polyol



Viscosity and MW

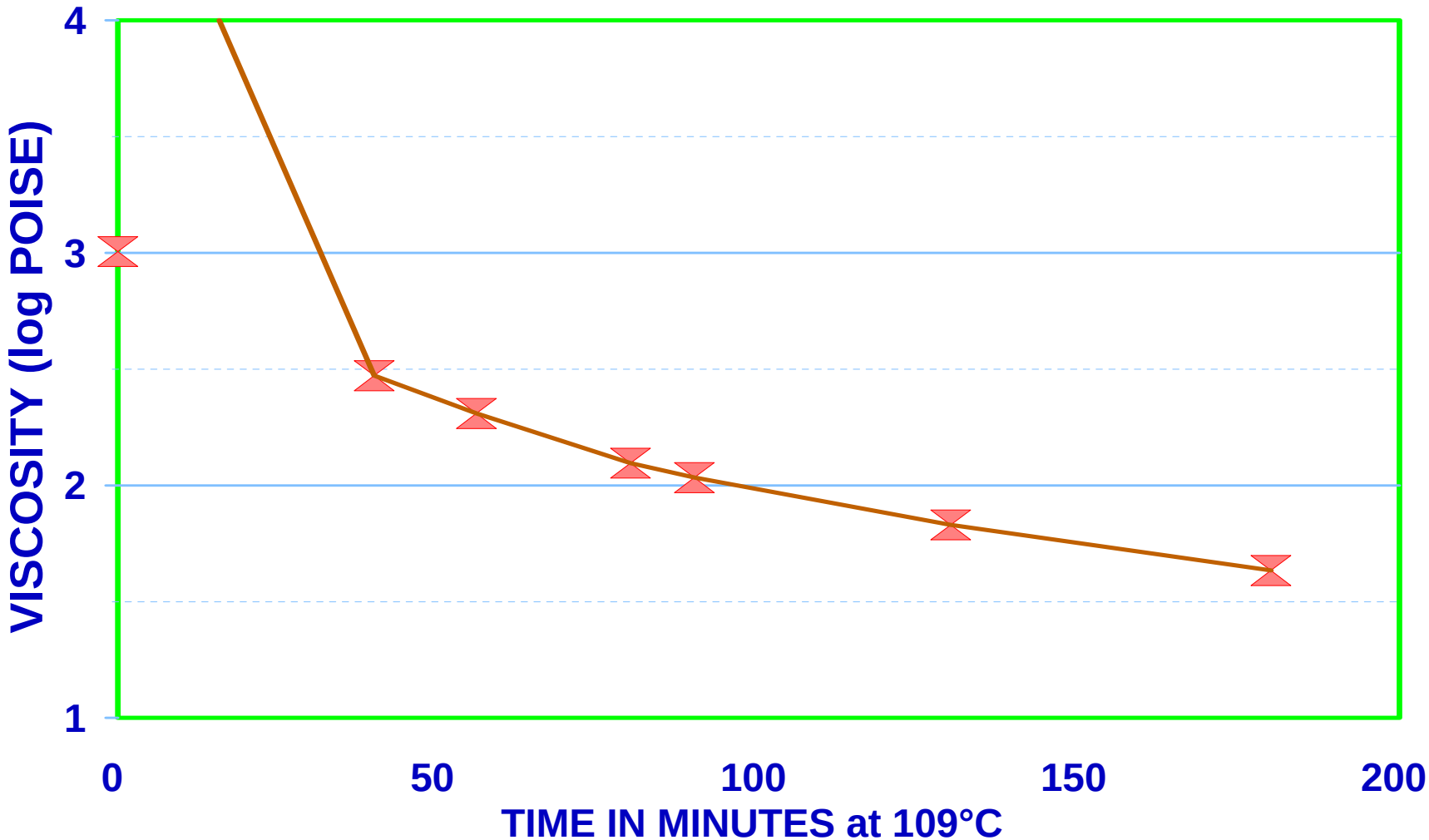
$$\log \eta = A + C \times Mw^{1/2}$$

Number average chain length

P.J.Flory J.Am.Chem..Soc., 62, 1057 (1940)

VISCOSITY OF POLYESTER BLEND

AT 109°C



SL2307

Solubility Parameter

Interaction parameter

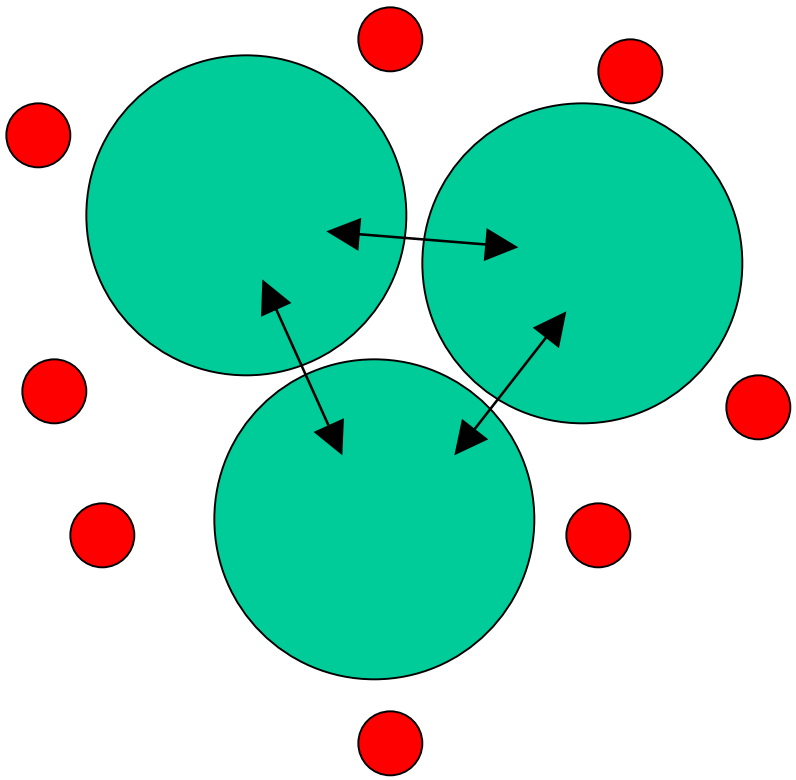
Cohesive energy

Hildebrand, Prausnitz

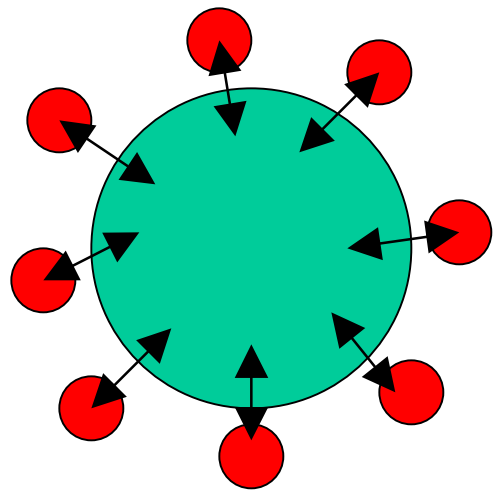
Hansen parameter

$$\delta^2 = \delta_d{}^2 + \delta_p{}^2 + \delta_h{}^2$$

Interaction parameter

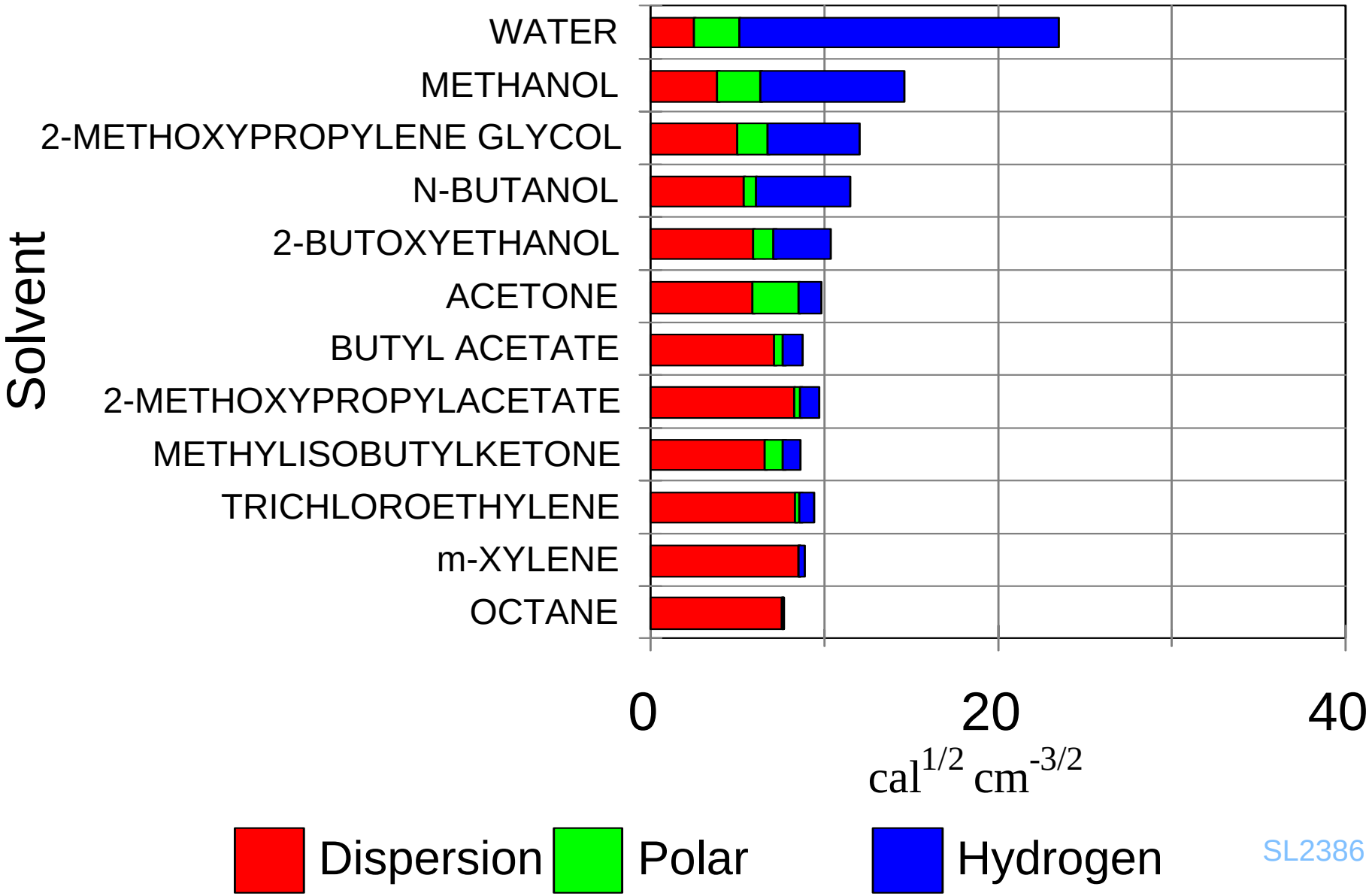


Weak Poly.-Sol.



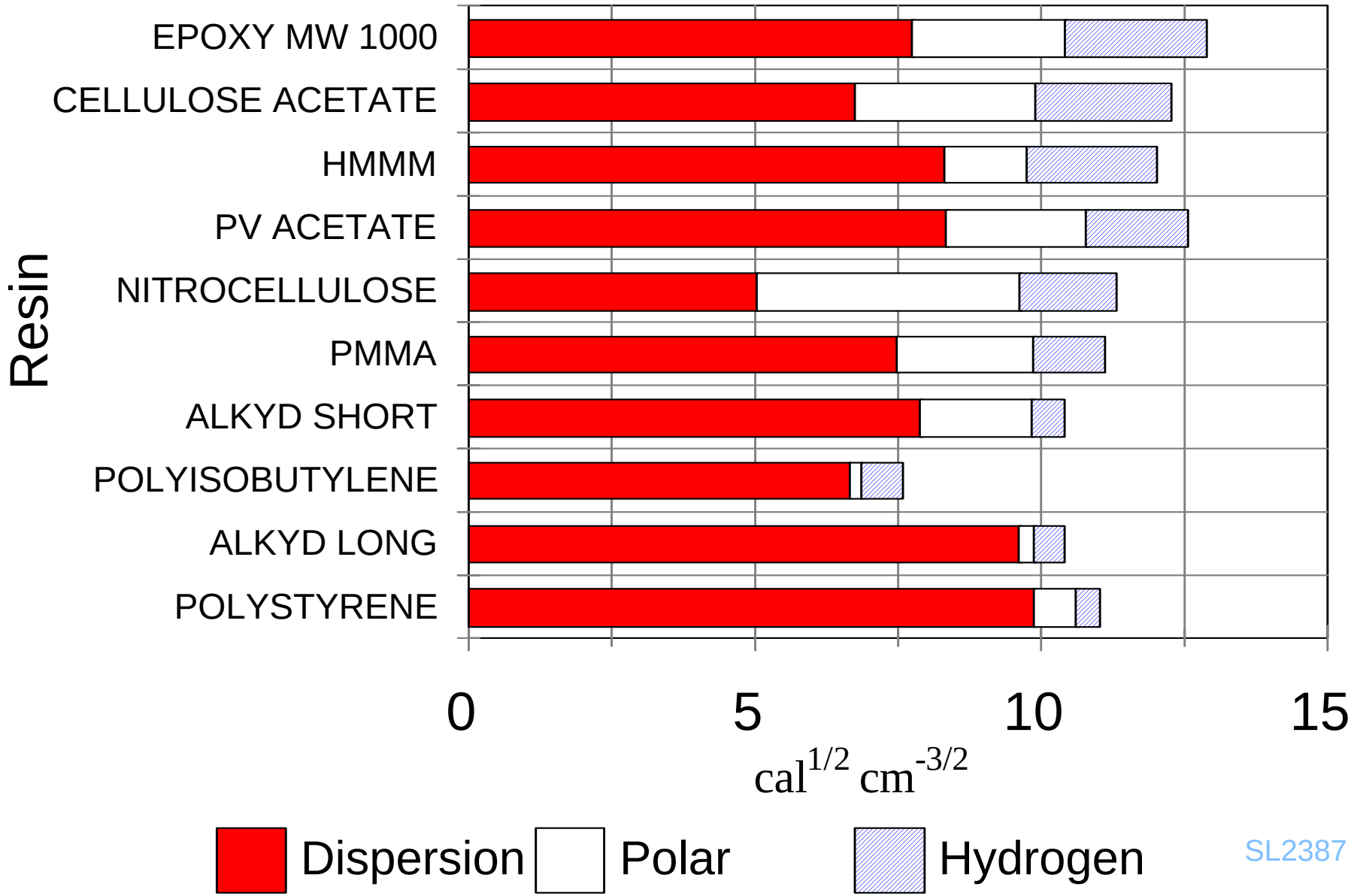
Strong Poly.-Sol.

Solubility Parameter



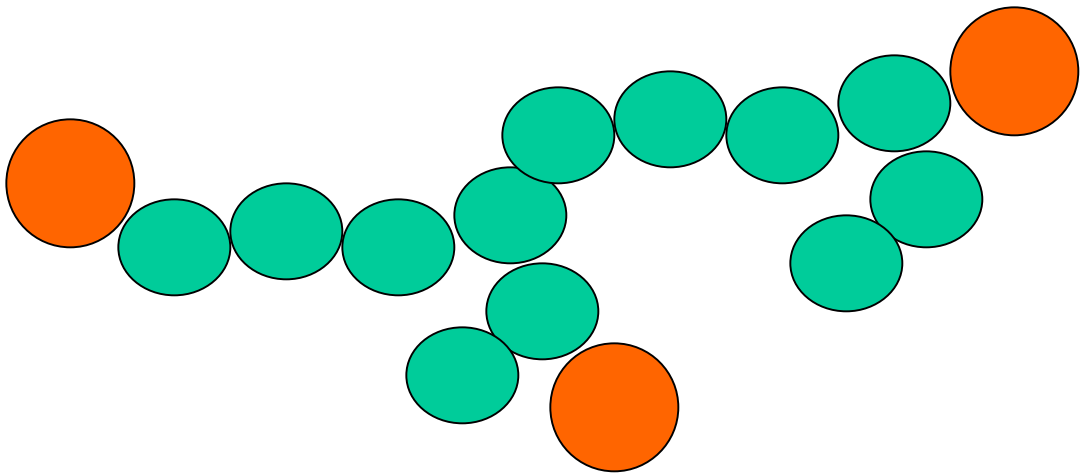
SL2386

Solubility Parameter

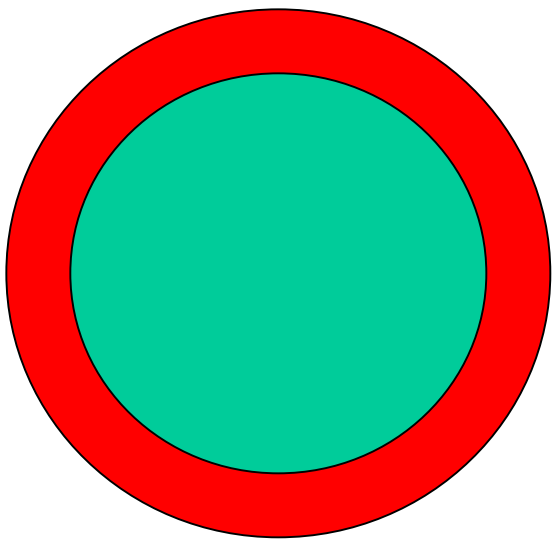


SL2387

Waterborne Coatings



Soluble

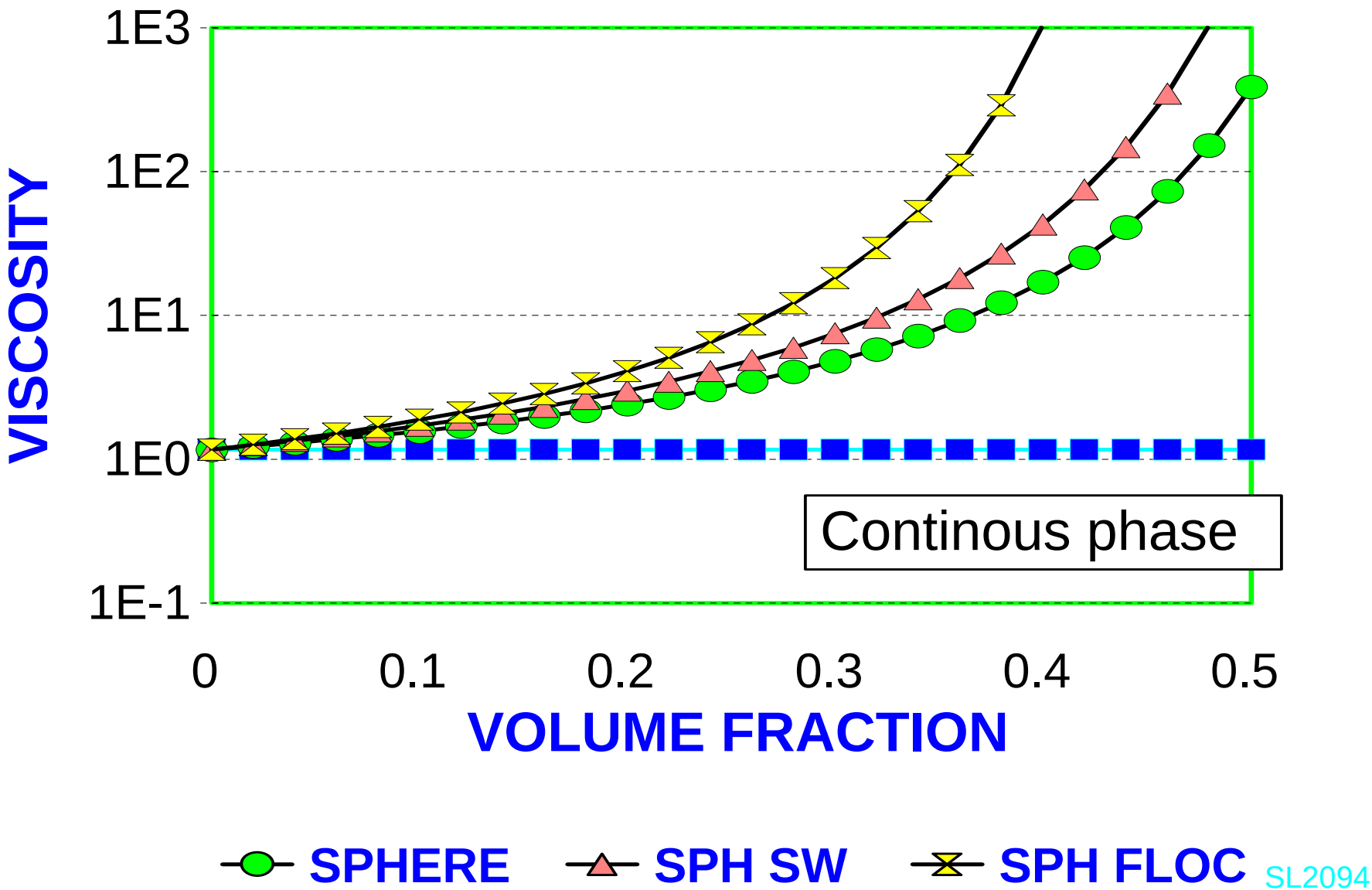


Dispersion

Waterborne coatings

	Acid number	Appearance
Soluble	50 - 200	Clear
Colloid	20 - 50	Turbid
Dispersion	0 - 20	White

VISCOSITY OF DISPERSION



SL2094

Mooney Equation

$$\log \eta = \log \eta_e \frac{k_e V_i}{2.303\,(1 - Vi/\theta)}$$

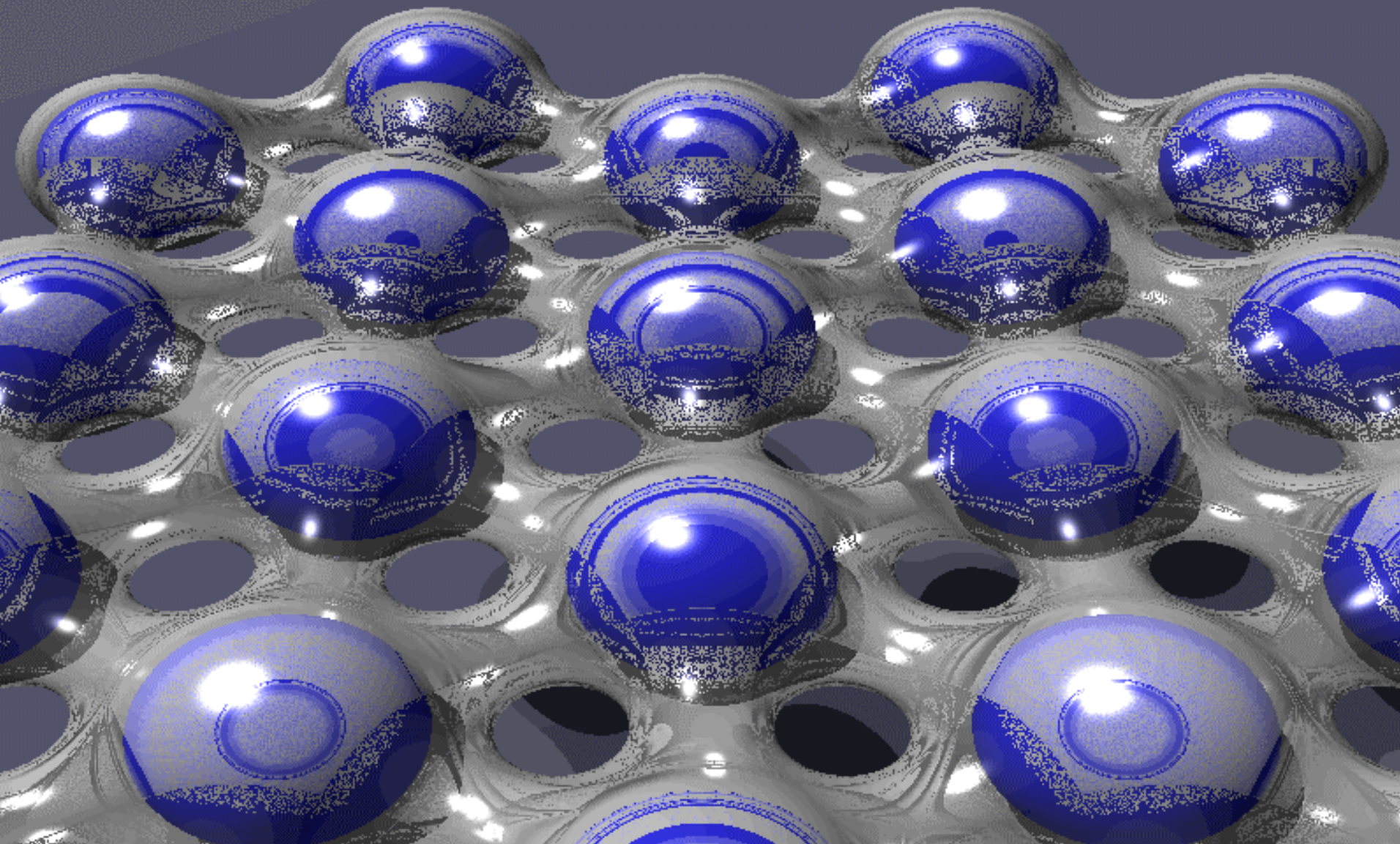
η_e = viscosity of medium

k_e = shape constant (2.5)

θ = packing factor

Vi = volume fraction

Coalescence

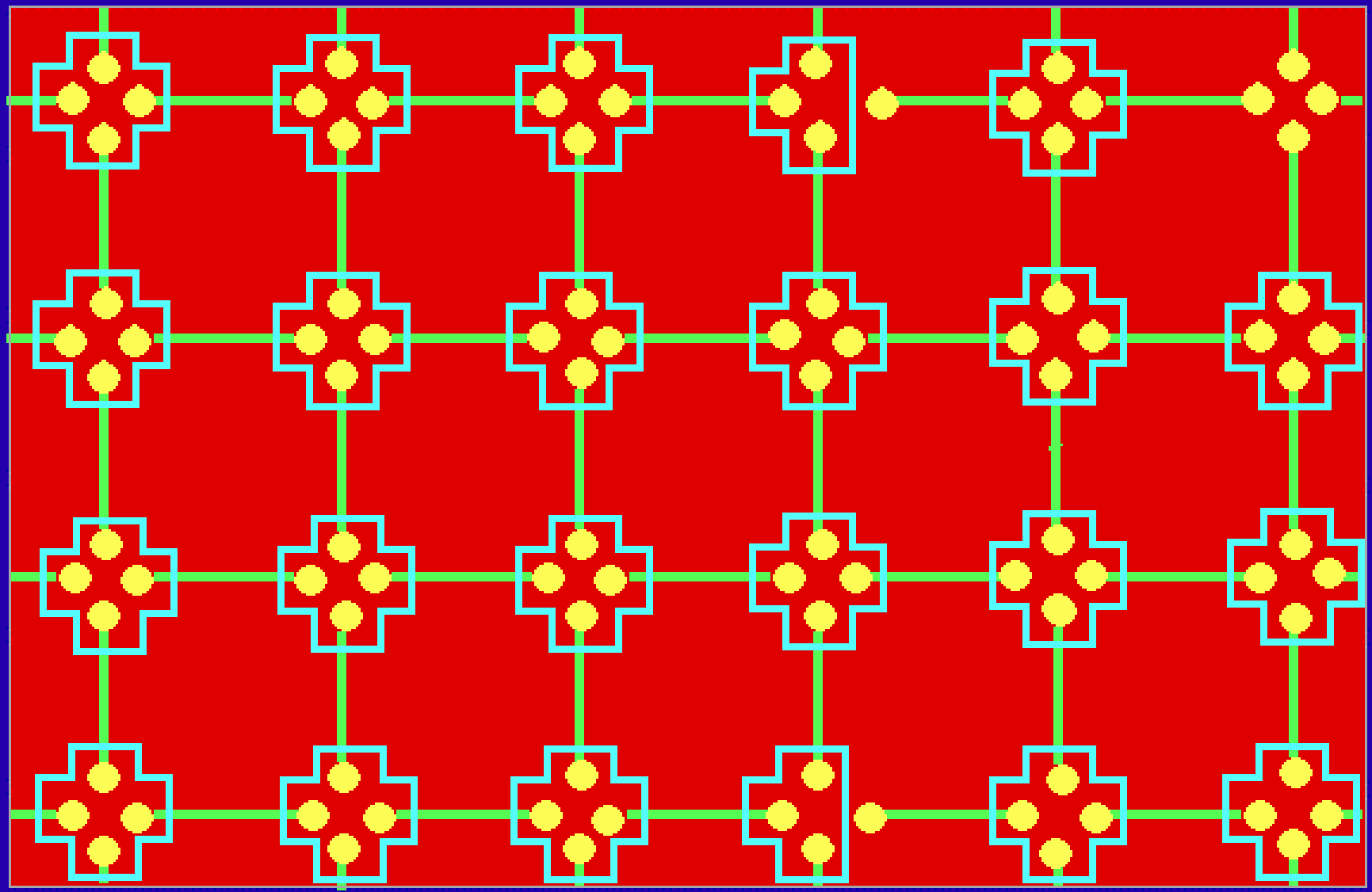


Crosslinking Creation of networks

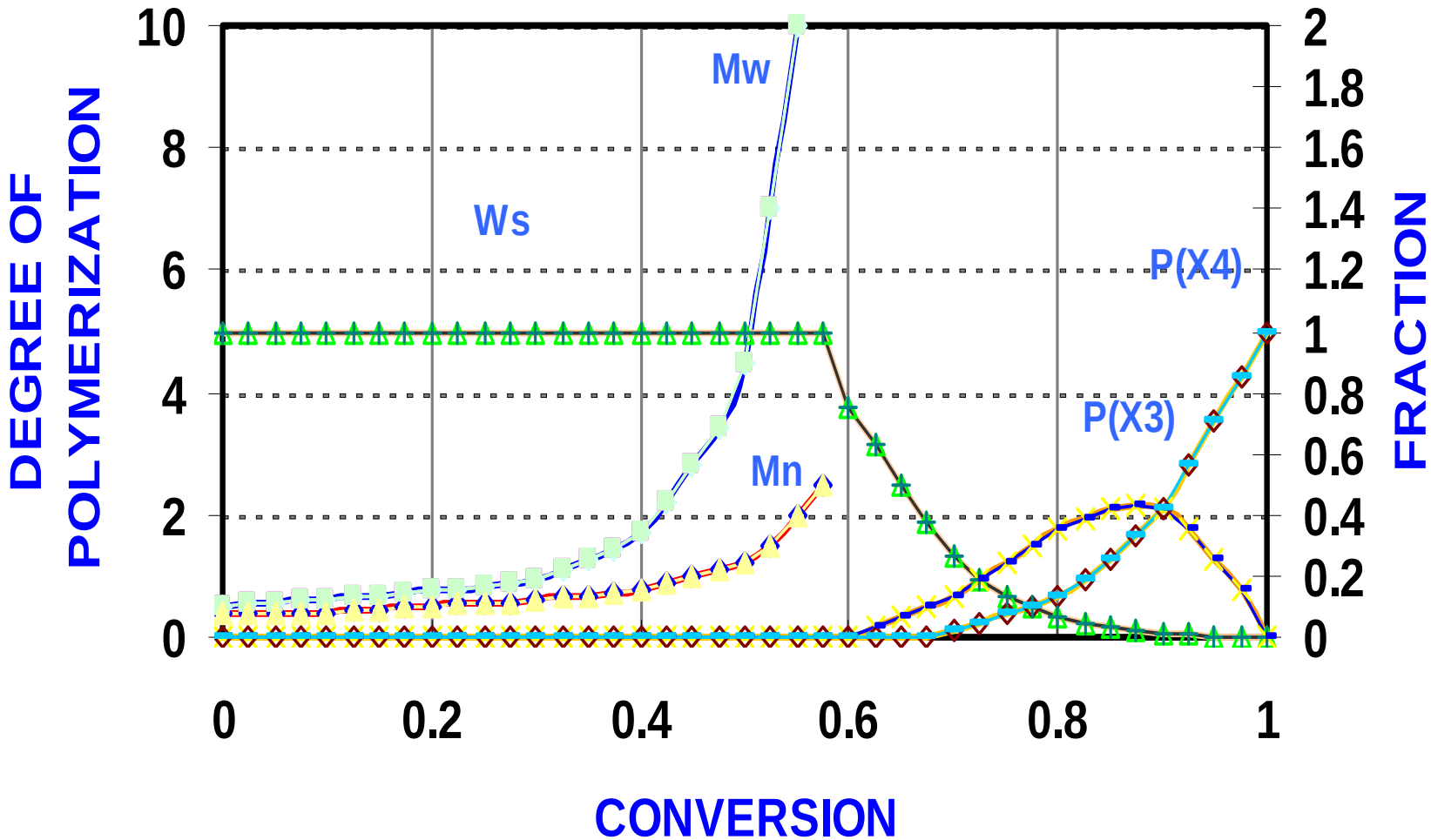
+	-
solvent resistance	elongation
hardness	flexibility
chemical resistance	
durability	
flexibility	
Tg	

CROSSLINKED NETWORK

TETRAFUNCTIONAL CROSSLINKER

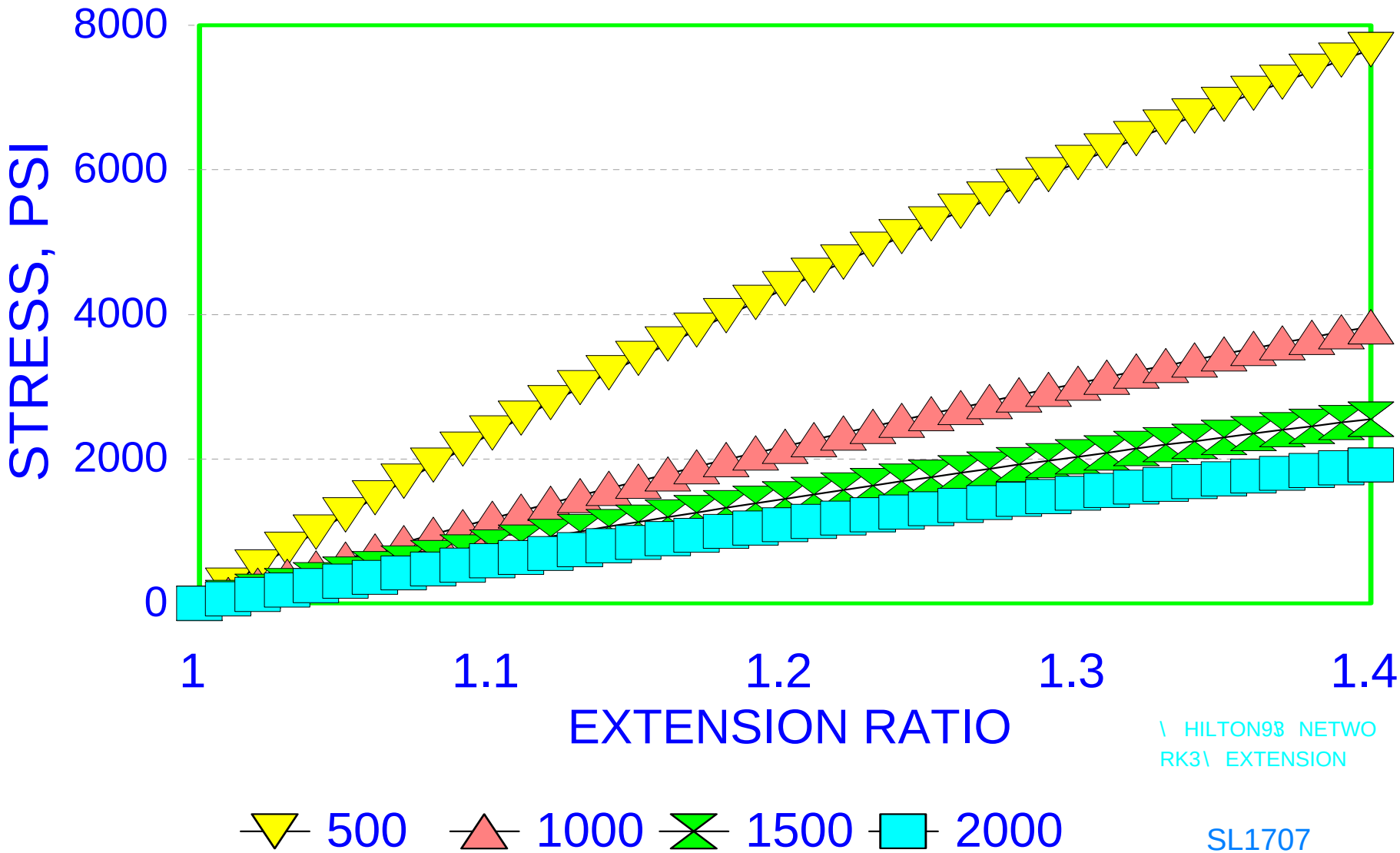


NETWORK FORMATION
A4 + B2



STRESS-STRAIN

FRONT FACTOR = 1



Flory-Rehner Equation

SWELLING OF POLYMERS

$$-[\ln(1 - v_2) + v_2 + x_1 v_2^2] = V_1 n[v_2^{1/3} - v_2/2]$$

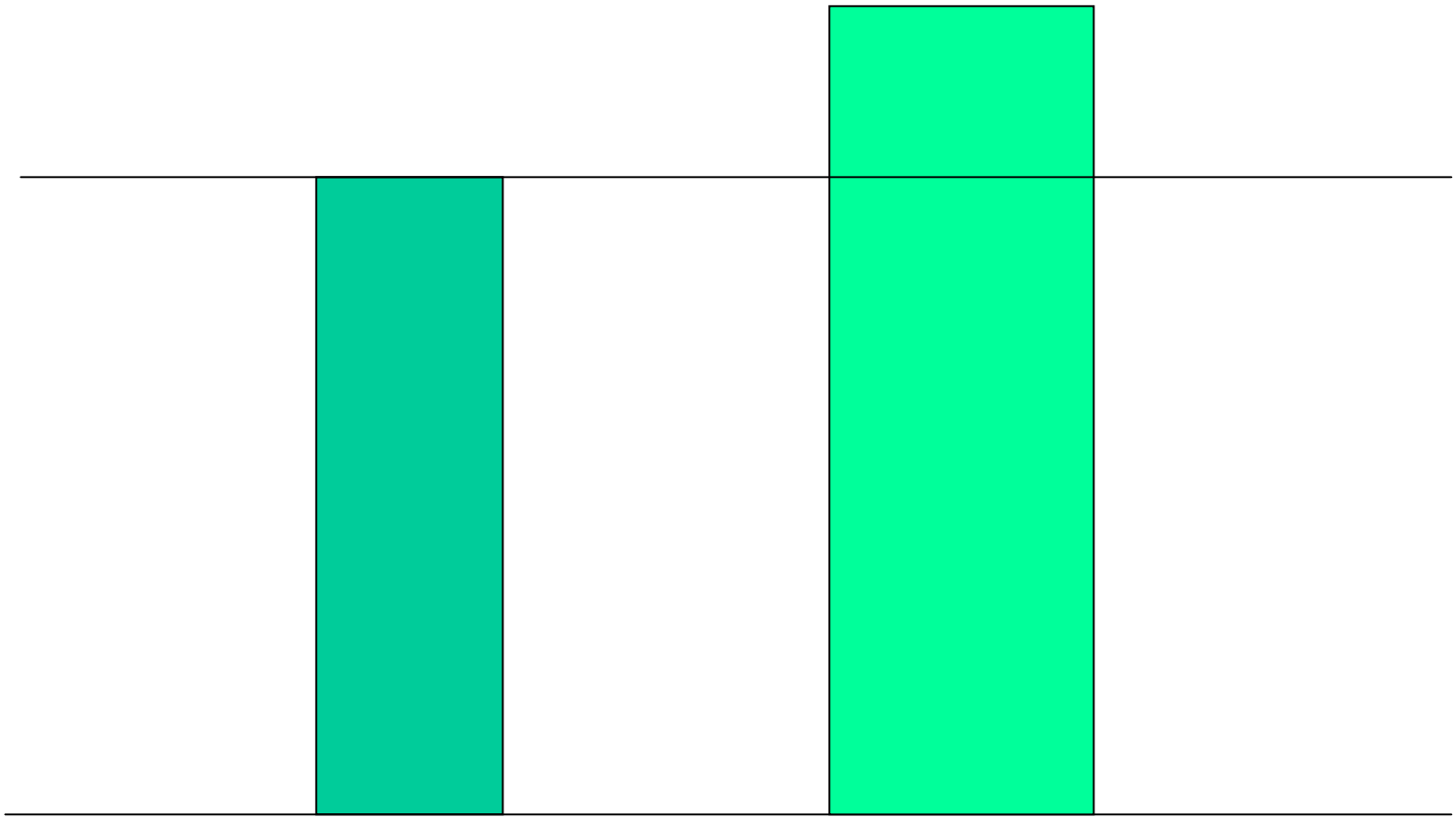
v_2 = Volume fraction of swollen polymer

V_1 = Molar volume of solvent

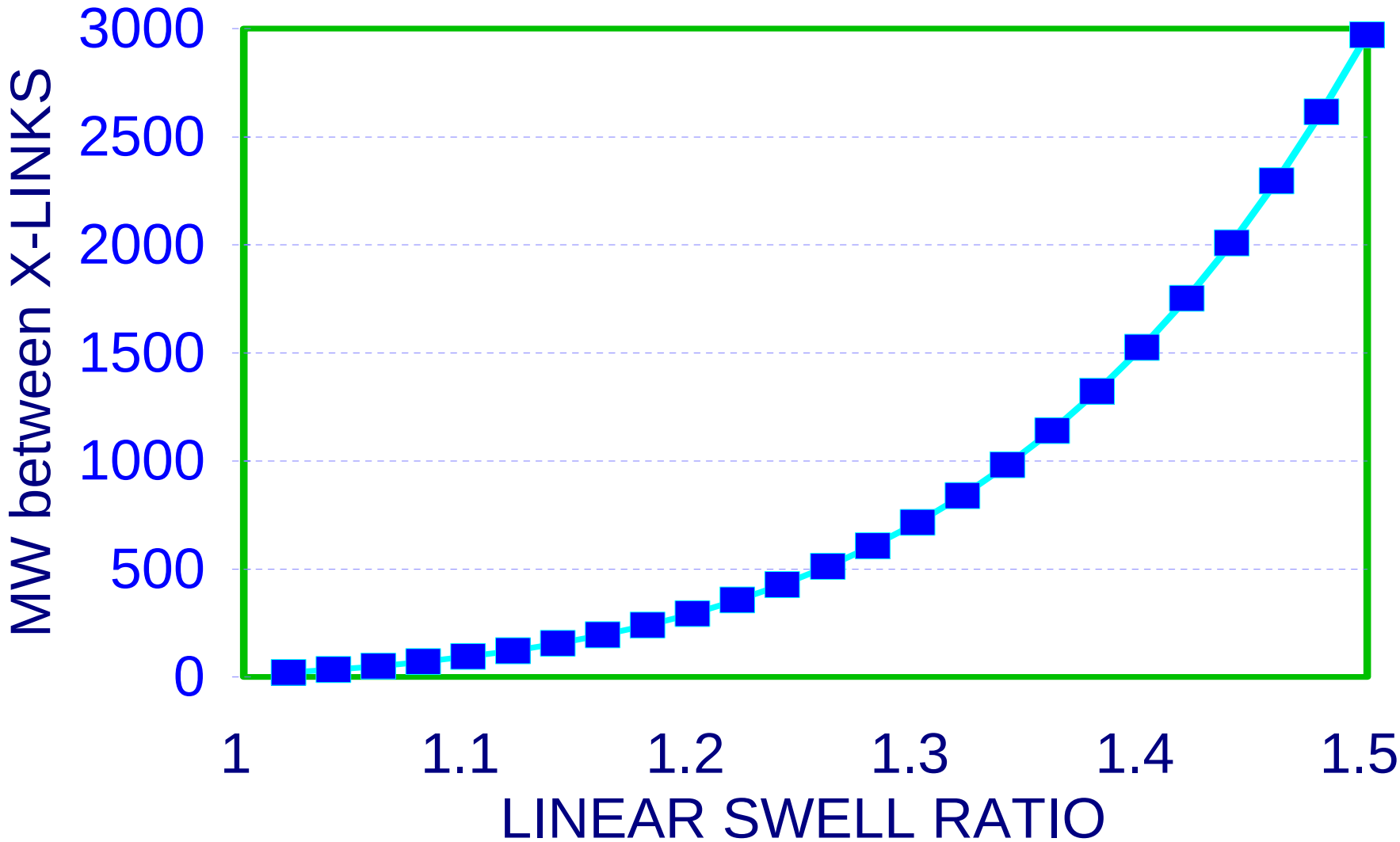
x_1 = Flory-Huggins interaction parameter

n = Number of active chains per volume

SWELL RATIO



SWELL RATIO AND MWxI



HILTON\ SWELCOM1

SL1757

POLYMERS

CHAIN GROWTH FREE RADICALS

ACRYLIC, VINYL

STEP GROWTH CONDENSATION

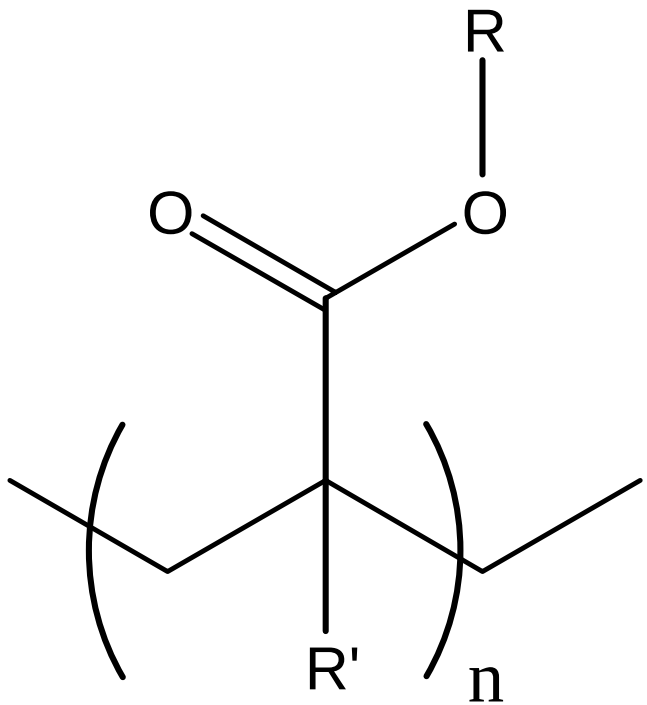
POLYESTER, ALKYD

EPOXY

MELAMINE

CHAIN GROWTH FREE RADICALS

ACRYLIC, VINYL



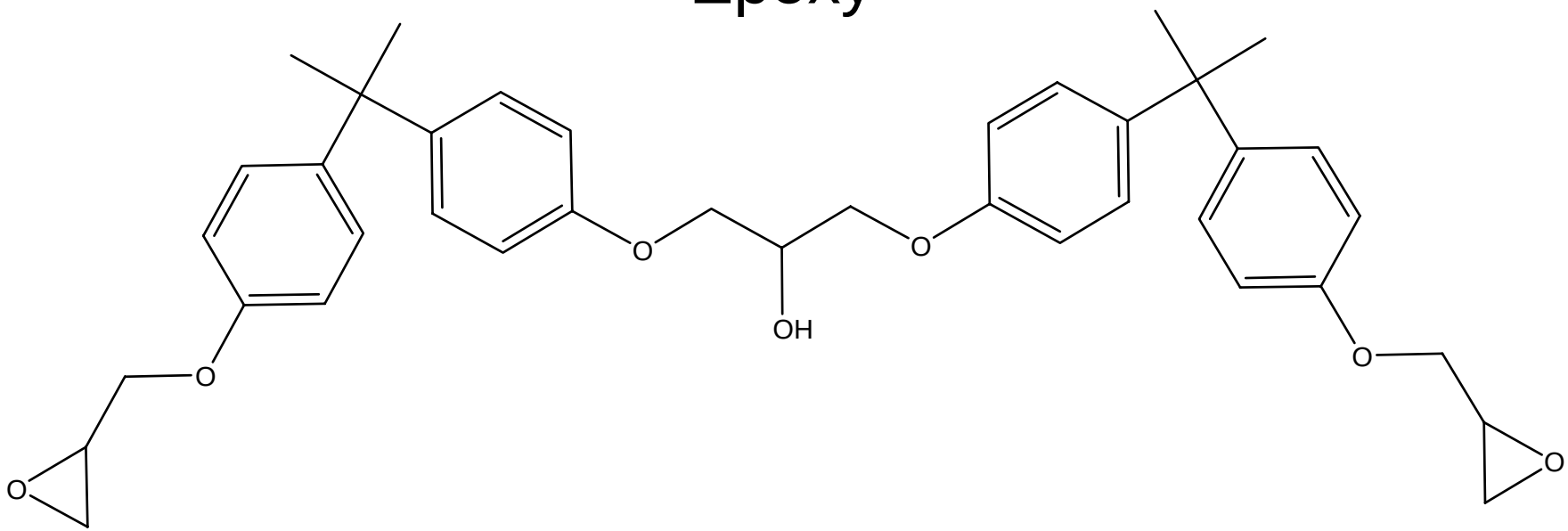
R= -H, -CH_2CH_2OH, C_1-C_8

STEP GROWTH CONDENSATION

Polyester

$$R\text{-}OH + R'COOH \rightarrow R\text{-}OCOR' + H_2O$$

Epoxy



Acknowledgment

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