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# NEW DEVELOPMENTS IN CATALYSIS

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# MARKET PLACE

## DRIVING FACTORS

ENVIRONMENTAL REGULATIONS  
SAFETY- HEALTH  
ENERGY

## DELAYING FACTORS

REGULATIONS  
FRAGMENTATION OF MARKETS  
UNCERTAINTY IN MARKET PLACE

# COATING TECHNOLOGIES

## HIGH SOLIDS - SOLVENT FREE

VISCOSITY/SOLIDS & POTLIFE/DRY TIME

## WATERBORNE

COSOLVENT, APPLICATION CONDITIONS

## ELECTROCOATING

DRY-TIME

PRODUCTION VOLUME, SUBSTRATE

CURE TEMPERATURE

## UV/EB COATING

COMPLEX OBJECTS, PIGMENTS

## POWDER COATING

LOW FILM THICKNESS, CURE TEMPERATURE

FLOW AND LEVELING

# CONDENSATION REACTIONS

Amino resins, melamine, urea formaldehyde

**FORMALDEHYDE, ALCOHOL, WATER**

Blocked isocyanate

**KETOXIME, PYRAZOL, ALCOHOL**

Silane, siloxane

**ALCOHOL**

Hydroxyethyl amide -carboxyl

**WATER**

Methylol amide, glycoluril, cyclic urea

**WATER**

Hydroxyl-carboxyl

**WATER**

# Ring Opening and Addition Reaction

Isocyanate, Uretdione, Carbodiimide

Cyclic acylurea

Epoxy, Glycidyl, Cycloaliphatic, Oxetane

Cyclic Carbonate

2-Oxazoline

Aziridine

Michael Addition

Azlactone

# CATALYST NEEDS

ISOCYANATE  
WATERBORNE 2K

POTLIFE-REACTIVITY  
WATER REACTION

BLOCKED ISOCYANATE  
URETDIONE

CURE TEMPERATURE

EPOXY

Yellowing, Reactivity

HYBRID SYSTEMS

MELAMINE  
BLOCKED ISOCYANATE  
ISOCYANATE  
SILOXANE

# CATALYSTS FOR ISOCYANATE SYSTEMS

## REQUIREMENTS

ORGANOTIN FREE

CATALYSE NCO – OH

POTLIFE – REACTIVITY

NO SIDE REACTION WATER REACTION

WATER REACTION

EXTERIOR DURABILITY

# SCREENING OF CATALYSTS

## APPLICATION TESTS FORMULATION

POTLIFE (2X VISC.)

GEL TIME

TACK FREE

DRY-THROUGH

## MODEL SYSTEMS (ANALYTICAL)

DISAPPEARANCE OF NCO

FORMATION OF URETHANE / UREA

MW

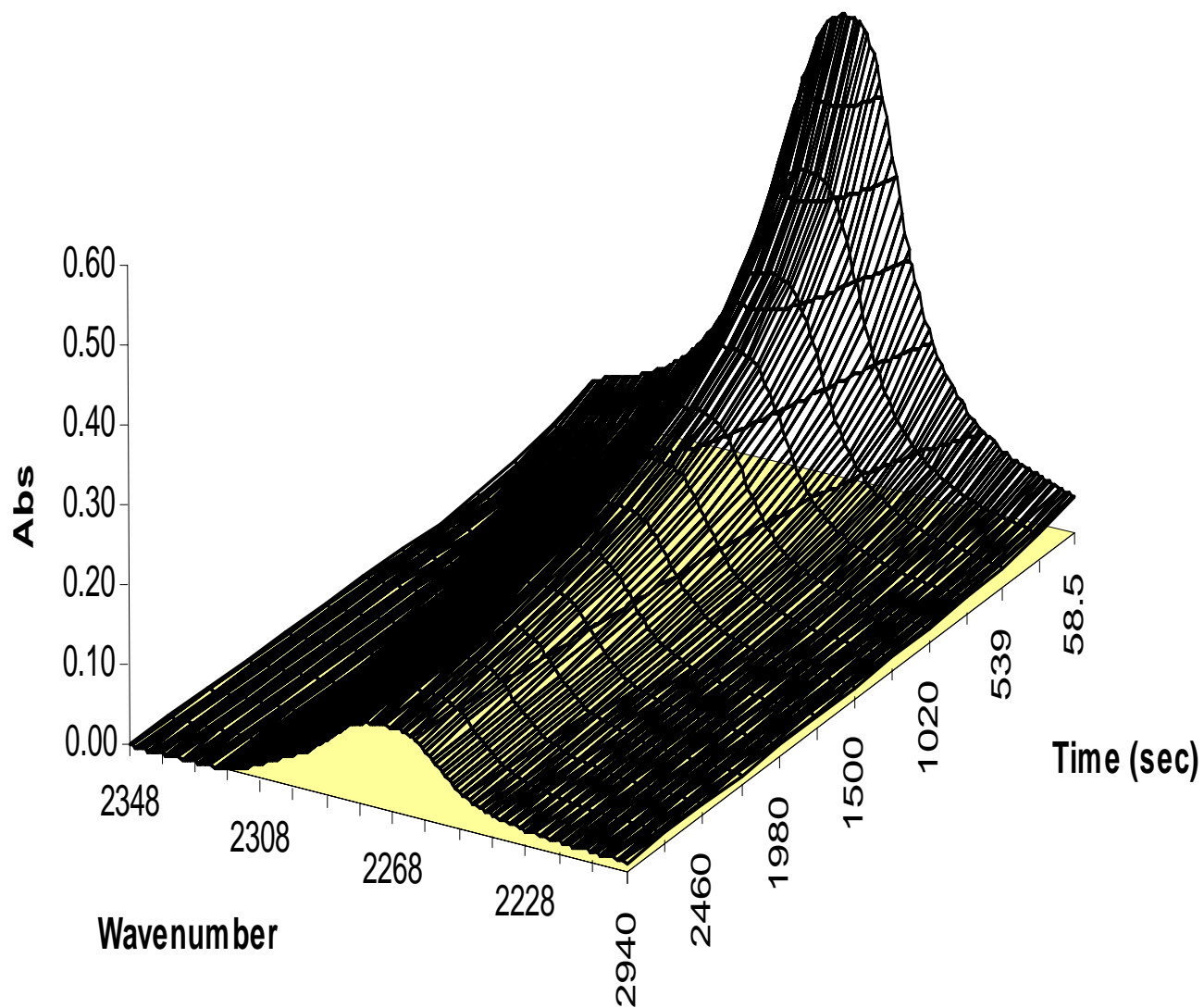


# Periodic Table

	1A													8A				
1	1 H	2A	Catalyst for NCO					Not a Catalyst					3A	4A	5A	6A	7A	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	3B	4B	5B	6B	7B	-----	8B		1B	2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt									

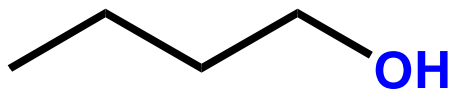
6	Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu			
7	Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr			

# Isocyanate Peak Decay

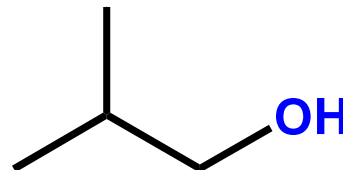


# FUNCTIONAL GROUPS USED

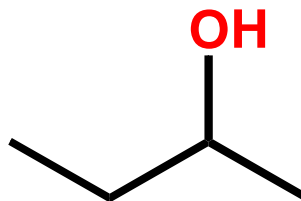
■ n-Butanol



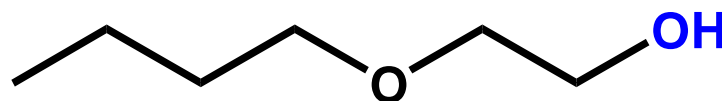
■ Isobutanol



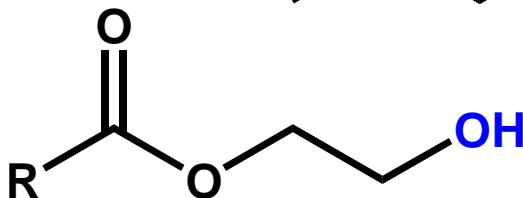
■ 2-Butanol



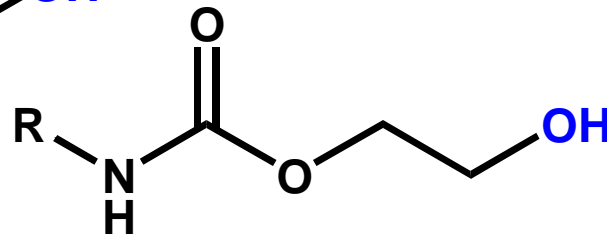
■ 2-Butoxyethanol



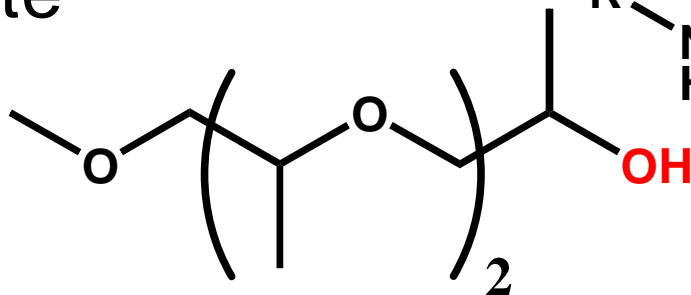
■ HE Ester



■ HE Carbamate



■ TPM



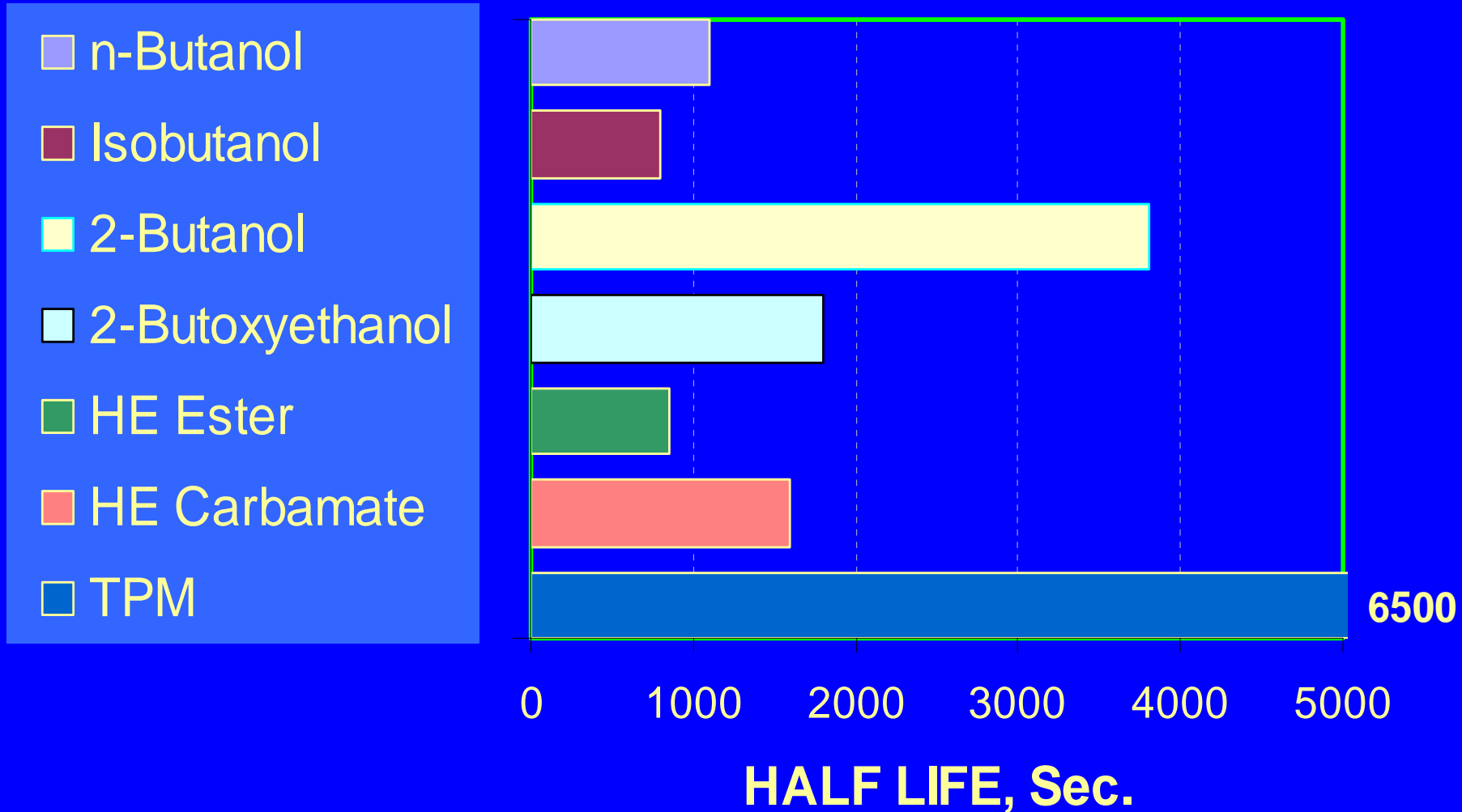
# CATALYSTS USED

Dibutyltin dilaurate	DBTDL
Zr dionate complex	Zr Chelate
Bi 2-ethylhexanoate	Bi Carboxyl
Zn 2-ethylhexanoate	Zn Carboxyl

## Reaction conditions

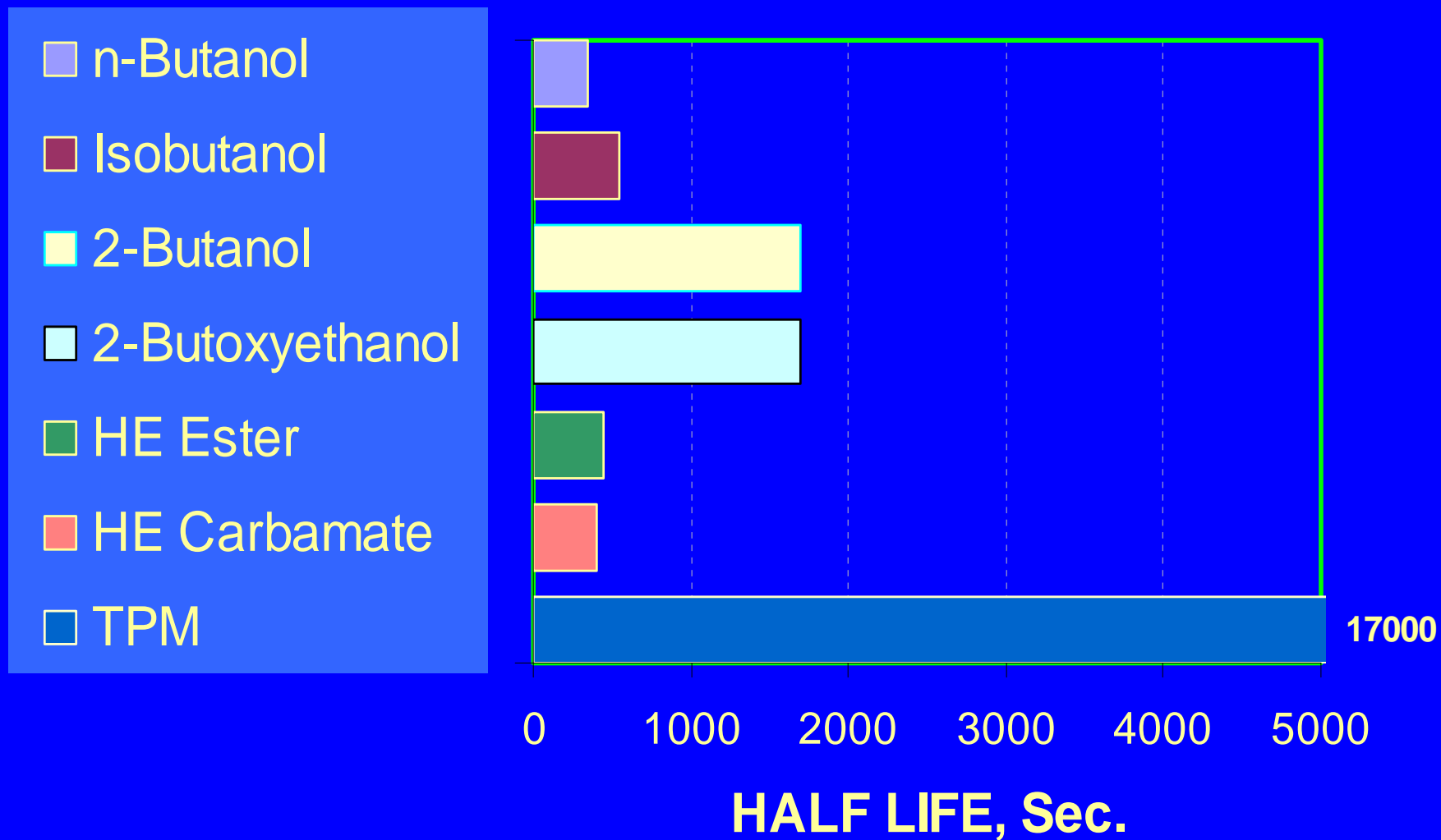
Solvent	Xylene
Isocyanate	HDI trimer
Isocyanate concentration, mol/l	1.12
NCO/OH	1/1
Temperature, °C	20

# HDI-TRIMER DBTDL 0.014 % Sn



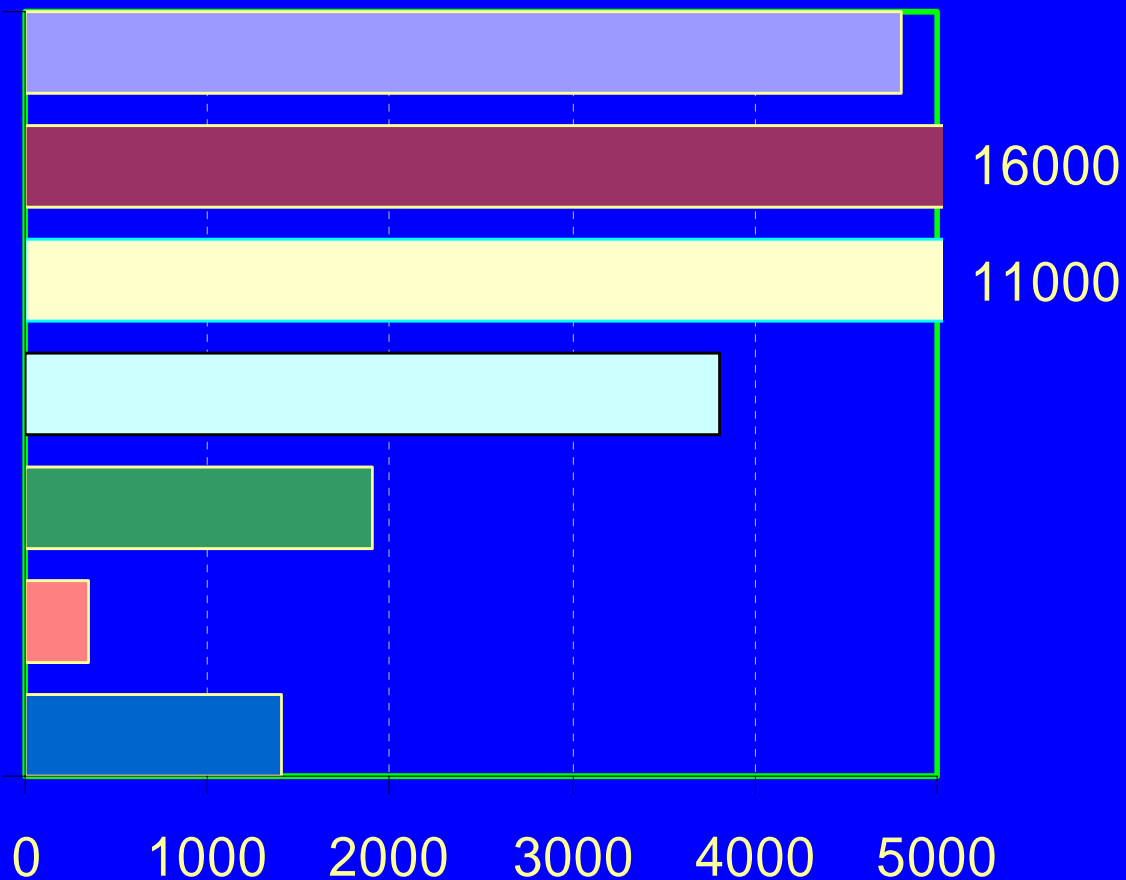
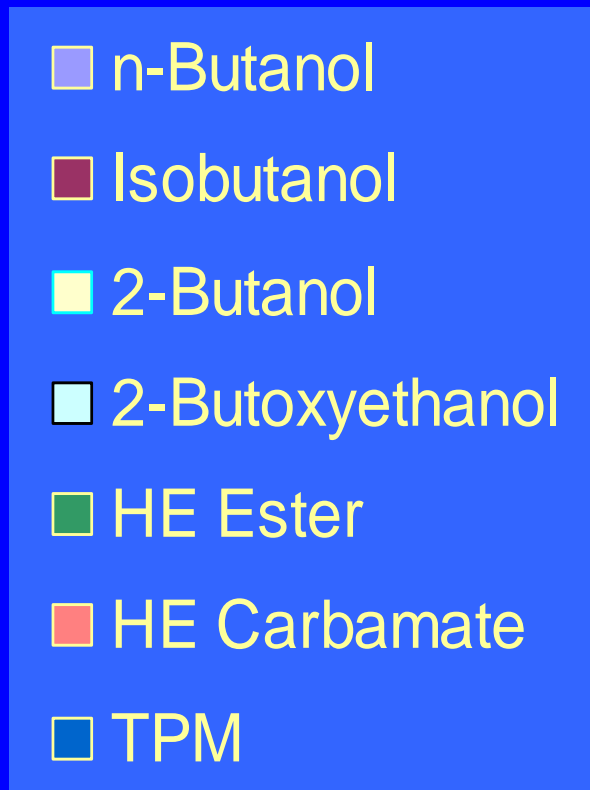
# HDI-TRIMER

## Zr Chelate 0.014 %Zr



# HDI-TRIMER

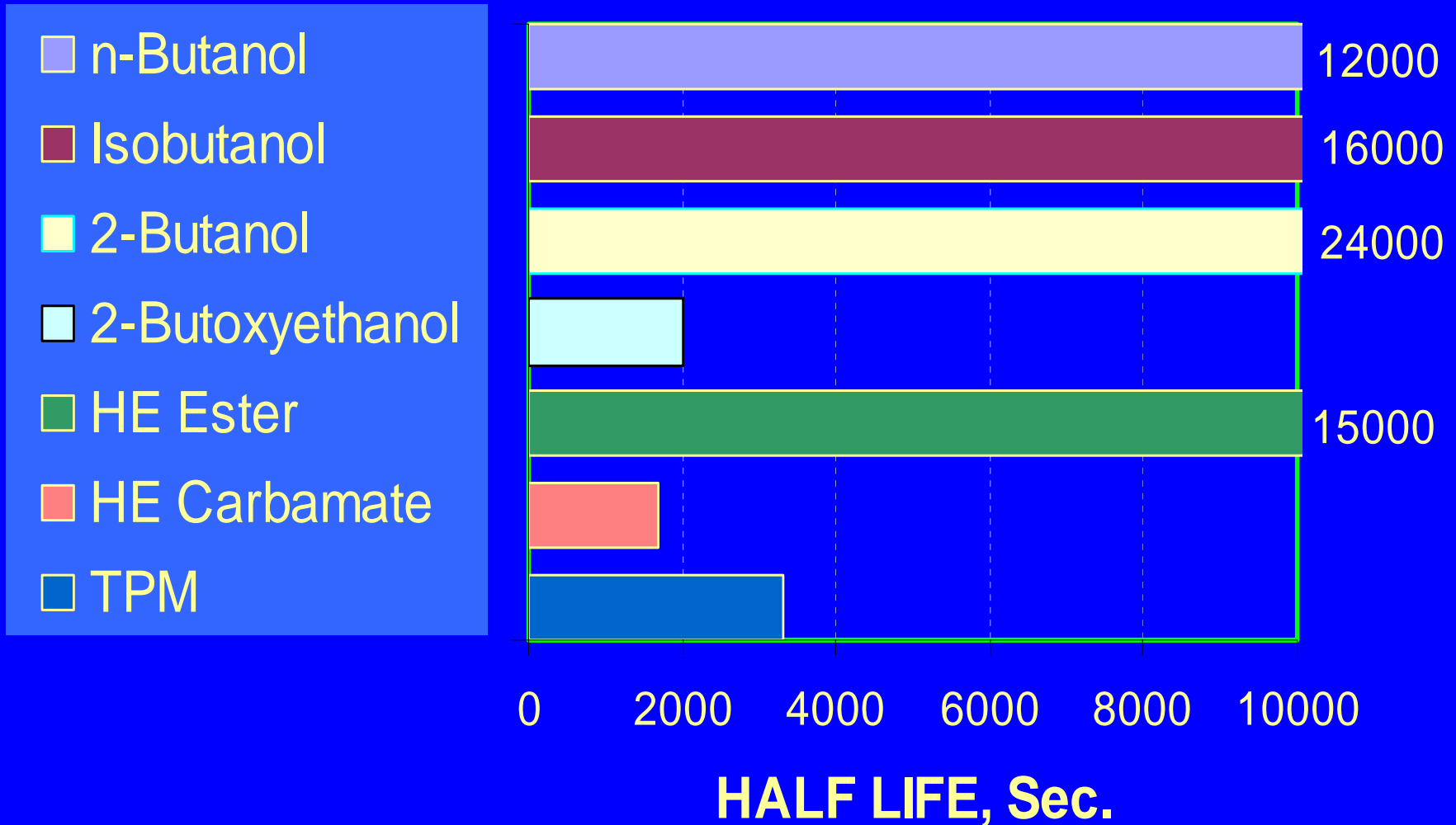
## Bi Carboxyl 0.14 % Bi



**HALF LIFE, Sec.**

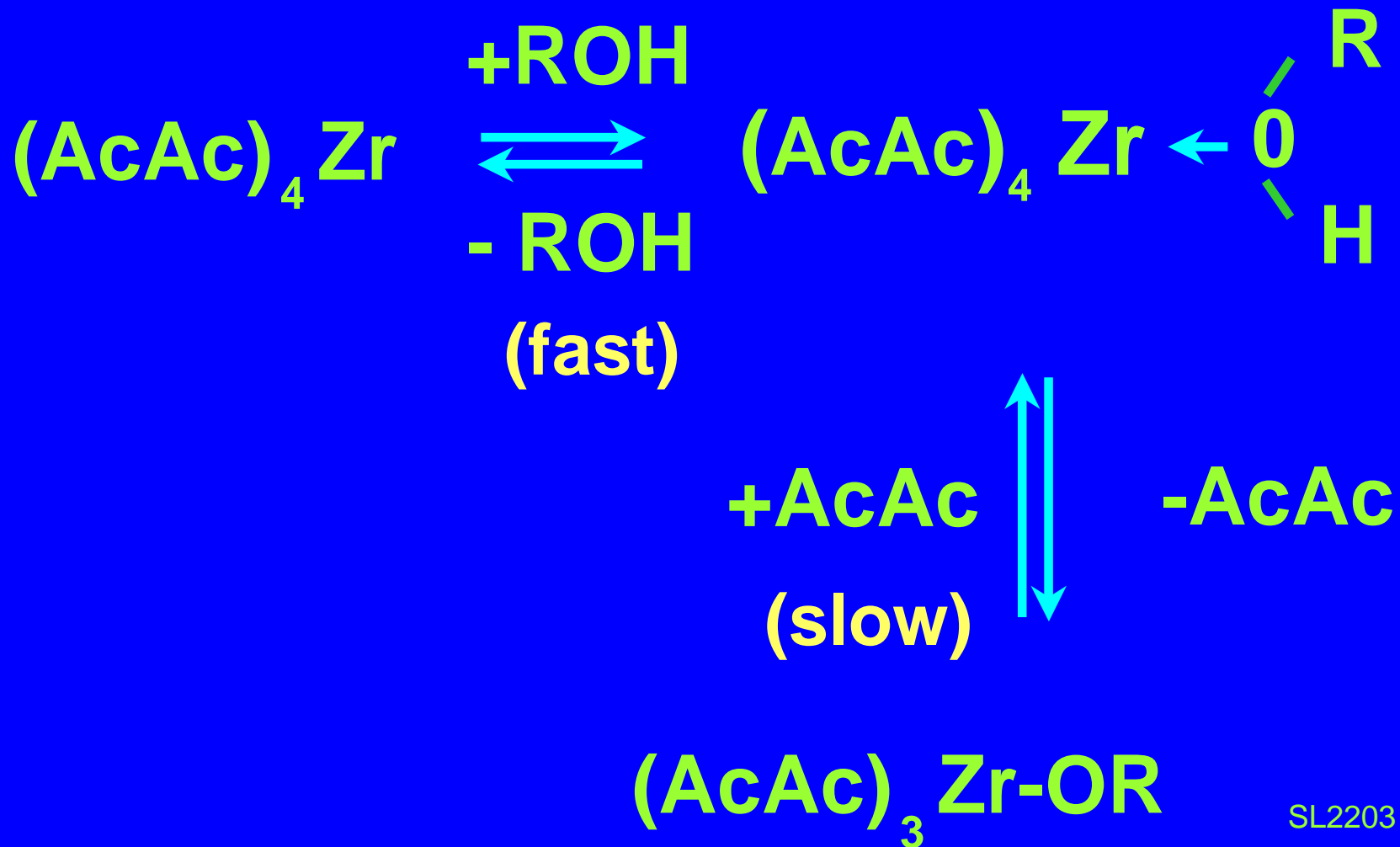
# HDI-TRIMER

## Zn Carboxyl 0.27 % Zn

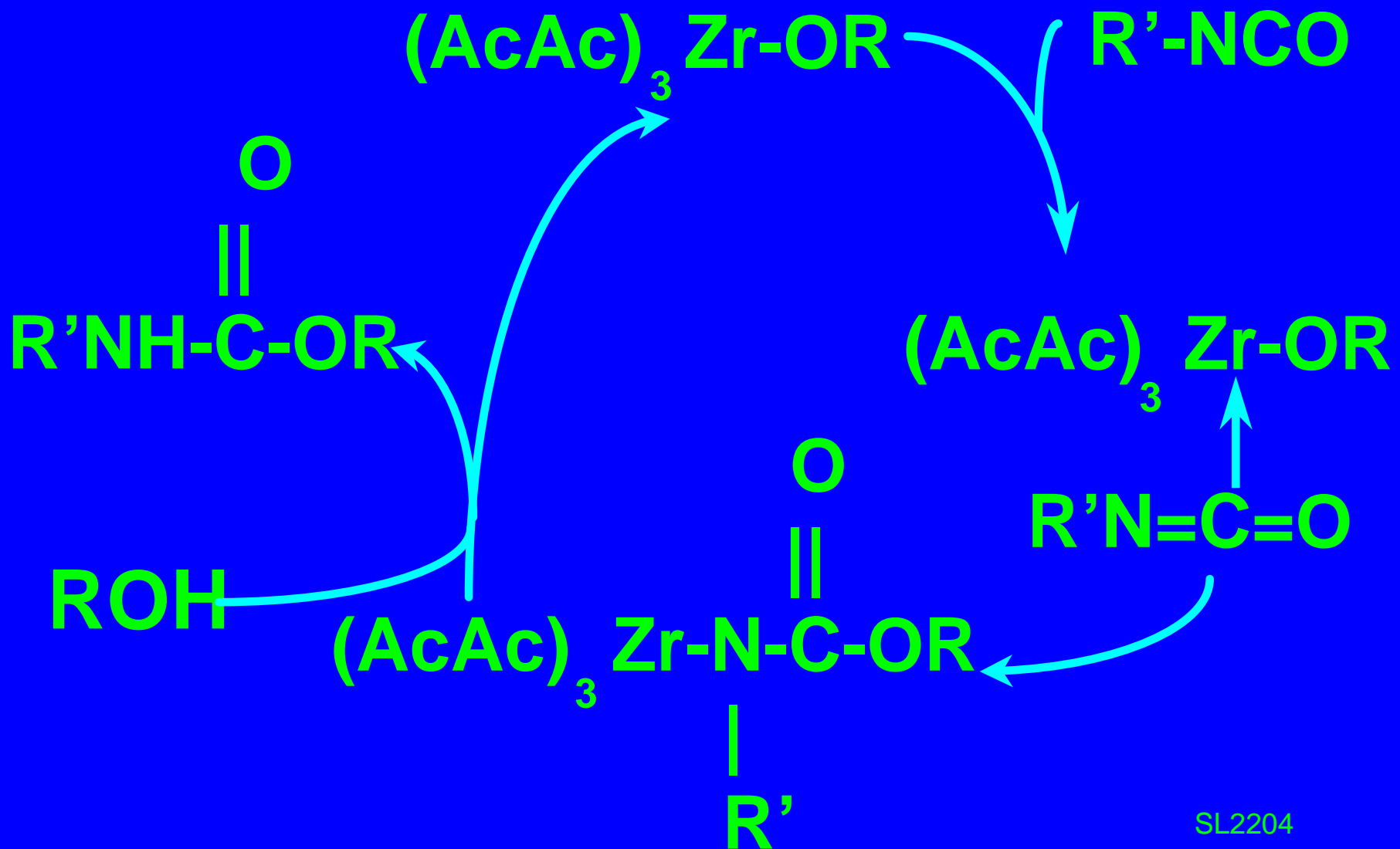




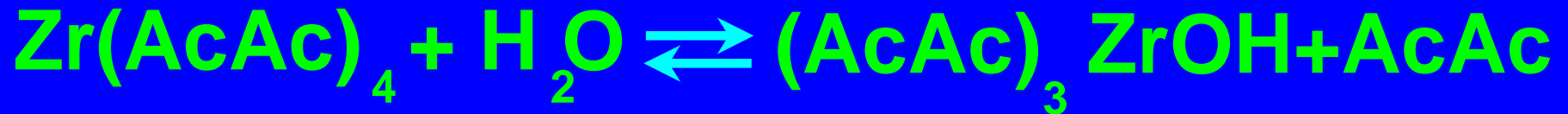
# ZIRCONIUM CHELATE CATALYSIS

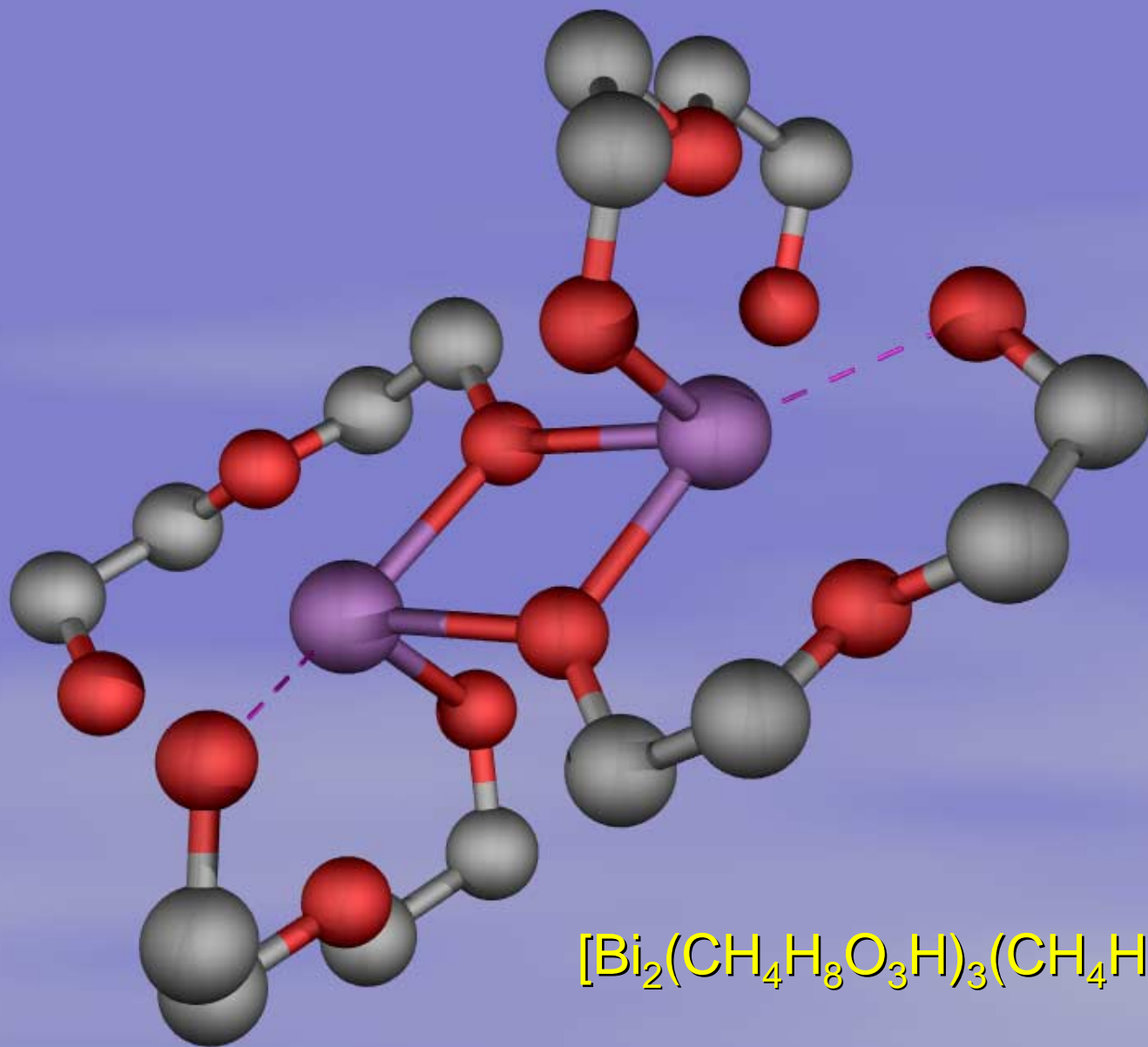


# ZIRCONIUM CHELATE CATALYSIS

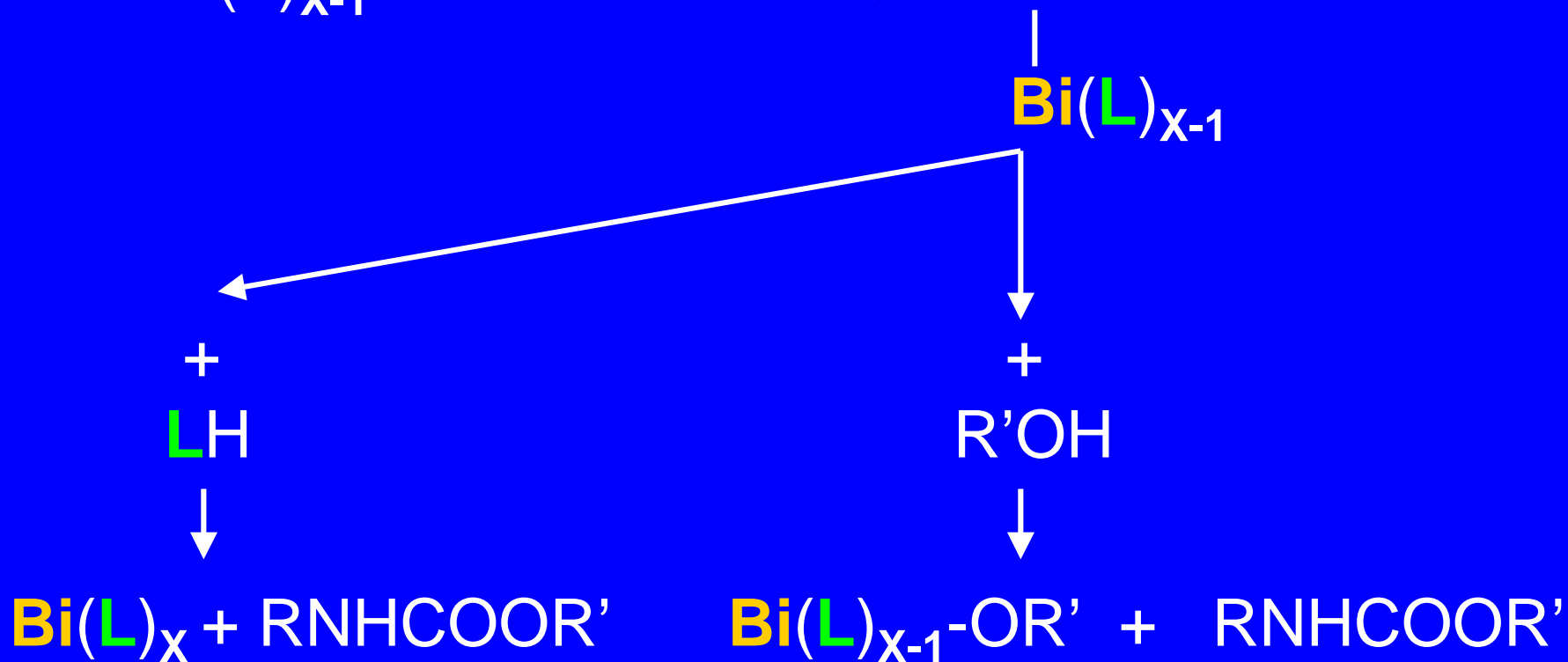
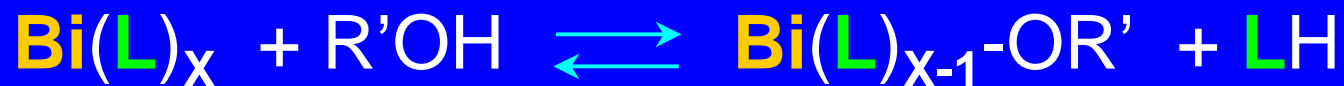


# HYDROLYSIS OF Zr CHELATE

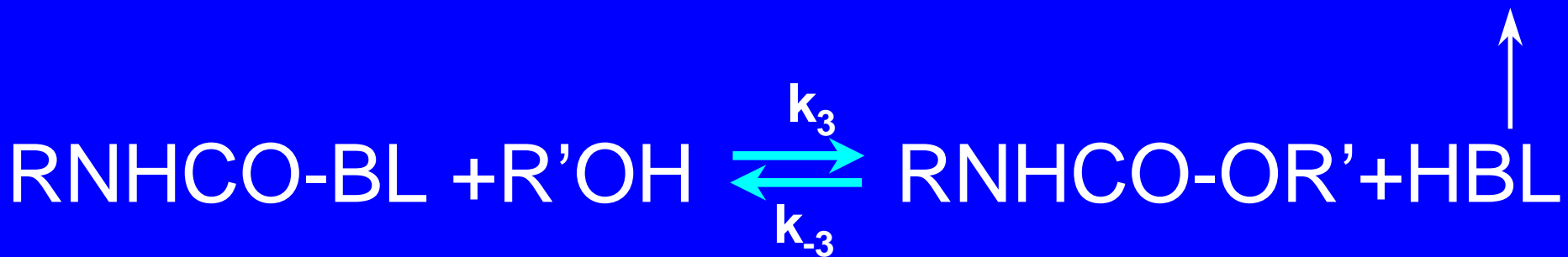
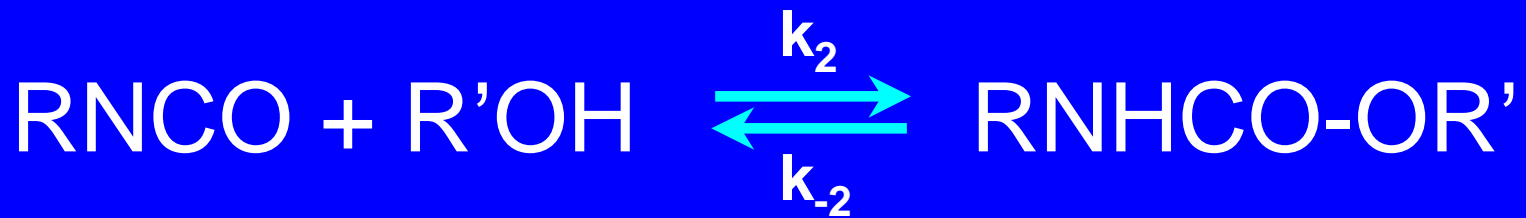
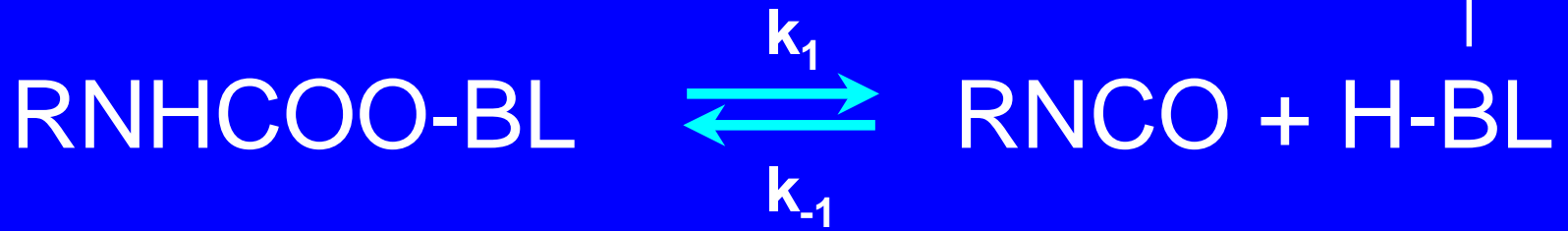




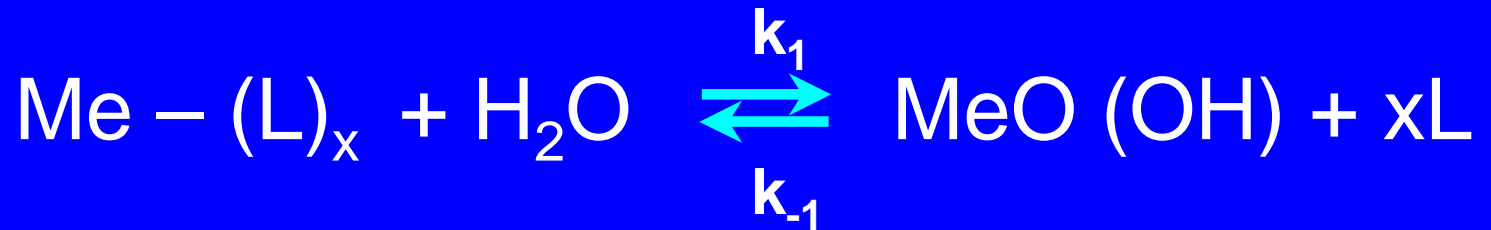
# Bismuth Catalysis



# REACTION OF BLOCKED ISOCYANATE



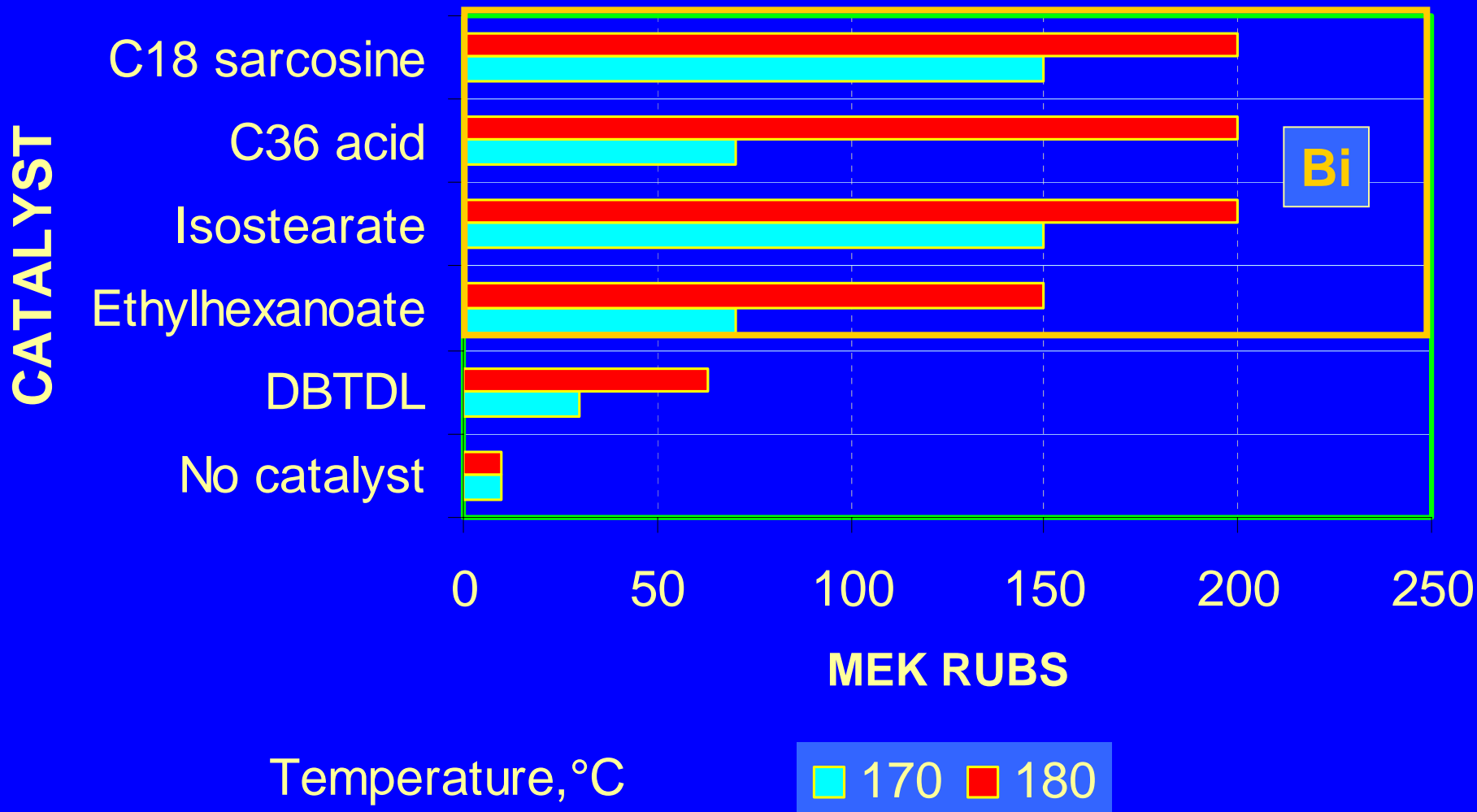
## CATALYST DEACTIVATION



## CATALYST REACTIVATION

# POLYMERIC MDI BLOCKED

Catalyst 0.25 % Me





# BLOCKING AGENTS - CATALYSTS

Malonate

Uretdione

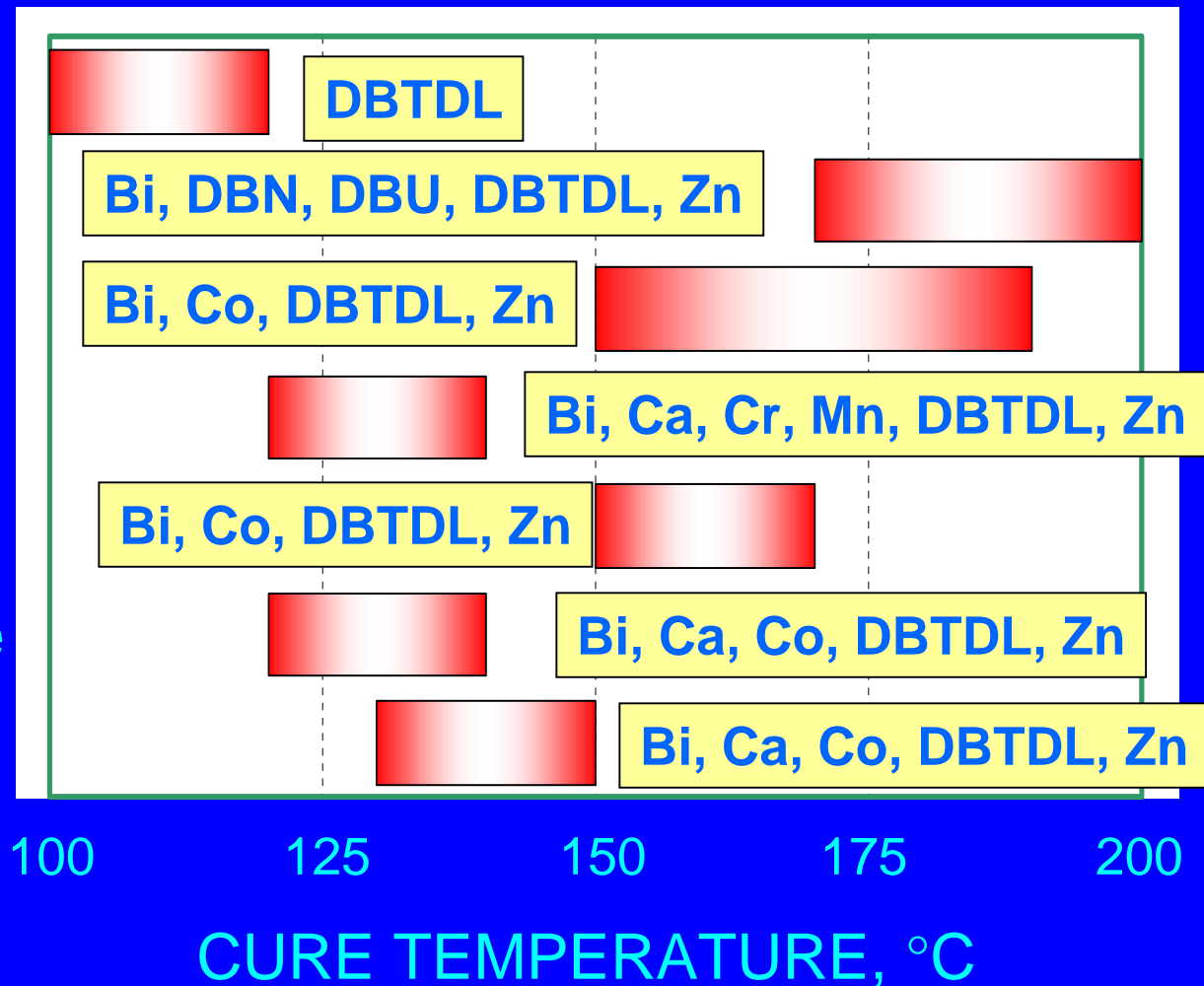
Alcohol

Phenol

Caprolactam

Dimethylpyrazole

Ketoxime



# AUTOMOTIVE CLEARCOATS

## Crosslinker

Melamine-formaldehyde

Isocyanate

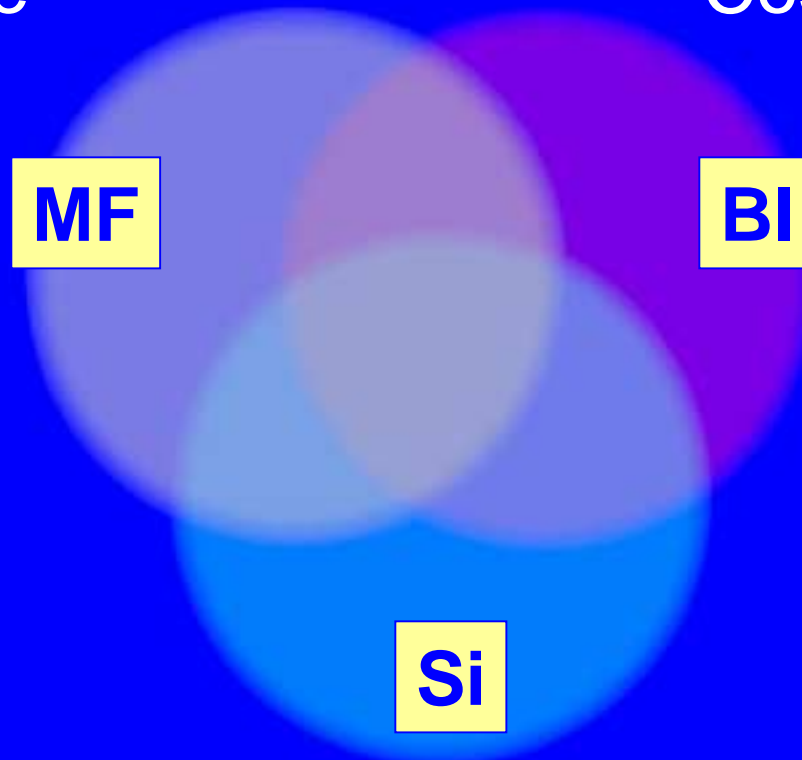
Siloxane

## Weakness

Acid etch

Scratch

Cost



# HYBRID CROSSLINKING

Melamine

R-PO<sub>4</sub>A

Bi. Isocyanate

RSO<sub>3</sub>H/A

Zn-CH

DBTDL

R-PO<sub>4</sub>A

RSO<sub>3</sub>R'

Al-Ch

Bi-Carb

DBTDL

Siloxane

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