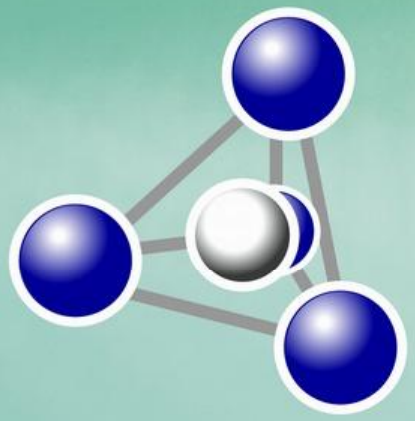
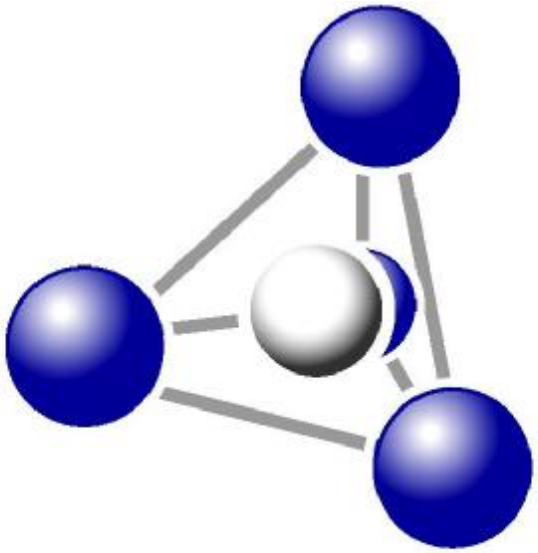


INSTITUT

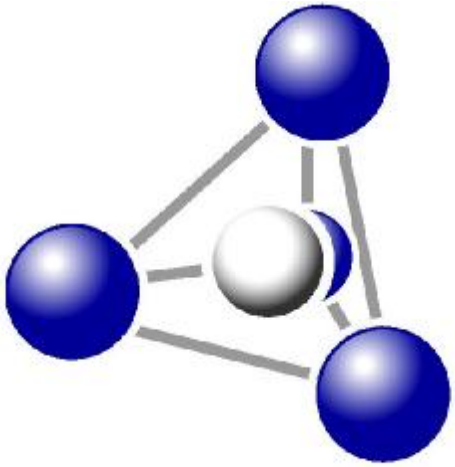
GÉOPOLYMÈRE

www.geopolymer.org



GEOPOLYMER

Prof. Dr. Joseph Davidovits



GEOPOLYMER

Advanced materials for the 21st century

Polymeric terminology

is the key to success


Amsterdam
London
Thalis train
Antwerpen
Eurostar
Tunnel
Bruxelles
Calais
Lille
Liège
A26
A2
Amiens
A29
Saint-Quentin
Le Havre
Rouen
A16
A1
TGV train
Train
A26
Reims
A4
Paris

1958

Rennes, France
Ingénieur Chimiste
E.N.S.C.R.

1960

Mainz, Germany
Dr. rer.nat
organic polymer

SONDERDRUCK AUS
DIE
NATURWISSENSCHAFTEN
SPRINGER-VERLAG · BERLIN · GÖTTINGEN · HEIDELBERG

1960 HEFT 23, S. 538/3

Über die orientierte Aufwachsung von Dio
streckter Polyamidfo

Organisch-chemisches Institut der Ur

W. KERN, J. DAVIDOVITS u

Eingegangen am 8. August 1960

Sonderdruck aus

DIE MAKROMOLEKULARE CHEMIE

Band XLIII Heft 1/2 · 1961 Seite 106–116

Röntgenographische Untersuchungen an linearen Oligourethanen

von

WERNER KERN, JOSEF DAVIDOVITS, KARL JOSEF RAUTERKUS
und GÜNTHER FRIEDRICH SCHMIDT

DR. ALFRED HÜTHIG VERLAG GMBH · HEIDELBERG

Extrait de «TEINTEX» - Revue Générale des Matières Colorantes, 60, Rue de Richelieu, PARIS-2e - N° 9 - Septembre 1963

Teintex 28, 721 (1963)

1963-1964

Contributions à l'étude de la structure des macromolécules linéaires

par Joseph DAVIDOVITS,

Extrait de «TEINTEX» - Revue Générale des Matières Colorantes, 60, Rue de Richelieu, PARIS-2e - N° 10 - Octobre 1963

Teintex 28(1963), 757

Filabilité et résistance à la rupture des polymères linéaires. Étude théorique. Exemples des Nylon 66 et 6.

(La micelle Macromoléculaire II)

Extrait de «TEINTEX» - Revue Générale des Matières Colorantes, 60, Rue de Richelieu, PARIS-2e - N° 11 - Novembre 1963

Les polymères linéaires. Étude théorique de la tinctoriabilité

(La micelle macromoléculaire III)

Extrait de «TEINTEX» - Revue Générale des Matières Colorantes, 60, Rue de Richelieu, PARIS-2e - N° 4 - Avril 1964

Les Polymères Linéaires

(La micelle macromoléculaire IV *)

A — Structure du polyacrylonitrile

B — Propriétés tinctoriales :

Coefficient de susceptibilité tinctoriale

1964-1966

ASSOCIATION FRANÇAISE DES INGENIEURS, CHIMISTES ET TECHNICIENS DES INDUSTRIES DU CUIR DE LA CHAUSSURE ET AUTRES INDUSTRIES UTILISATRICES (A.F.I.C.T.I.C.)

CONTRIBUTION A L'ETUDE STRUCTURALE DU COLLAGENE

Etude théorique-Utilisation du modèle de la micelle macromoléculaire

par JOSEPH DAVIDOVITS

Tannerie

L'étude qui va suivre es
de la structure quaternaire
de départ est le modèle di
déjà fait l'objet d'un certai

J. Theoret. Biol. (1966) **12,** 1–11

The Quaternary and Fibrillar Structure of Native Collagen

J. DAVIDOVITS

Tanneries de France, Strasbourg–Lingolsheim, France

(*Received* 21 *October* 1965, *and in revised form* 17 *January* 1966)

A theoretical discussion of the quaternary and fibrillar structure of the native collagen molecule is based on a macromolecular micelle model. The macromolecular micelle is a macromolecular chain wound into a spiral which consists of straight lengths of chains and curves, the general form being in the solid state a planar ovoid disk which is able to swell in solution. The micelle is characterized by the length, L_0, of the first

1969-1971

itf

Prochaine publication

Le prochain est soumis et paraîtra dans un prochain bulletin de l'ITF.

J. DAVIDOVITS (*)

NOTE SUR LA STRUCTUR
DES FIBRES DE POLYE
SOUMISES A DES TRAITEMENTS

Une interprétation de rés
obtenus en microscopie élec

extrait du bulletin de

l'Institut Textile de Fran

Bull. Scient. ITF, V. 1, n° 3 1972

LA MORPHOLOGIE DES FIBRES SYNTHETIQUES

REMARQUES SUR LES MODELES DE STRUCTURES. LE MECANISME PROBABLE DE FORMATION DU FILAMENT

par

Joseph DAVIDOVITS

Omnium de Prospective Industrielle – Saint Quentin


1972

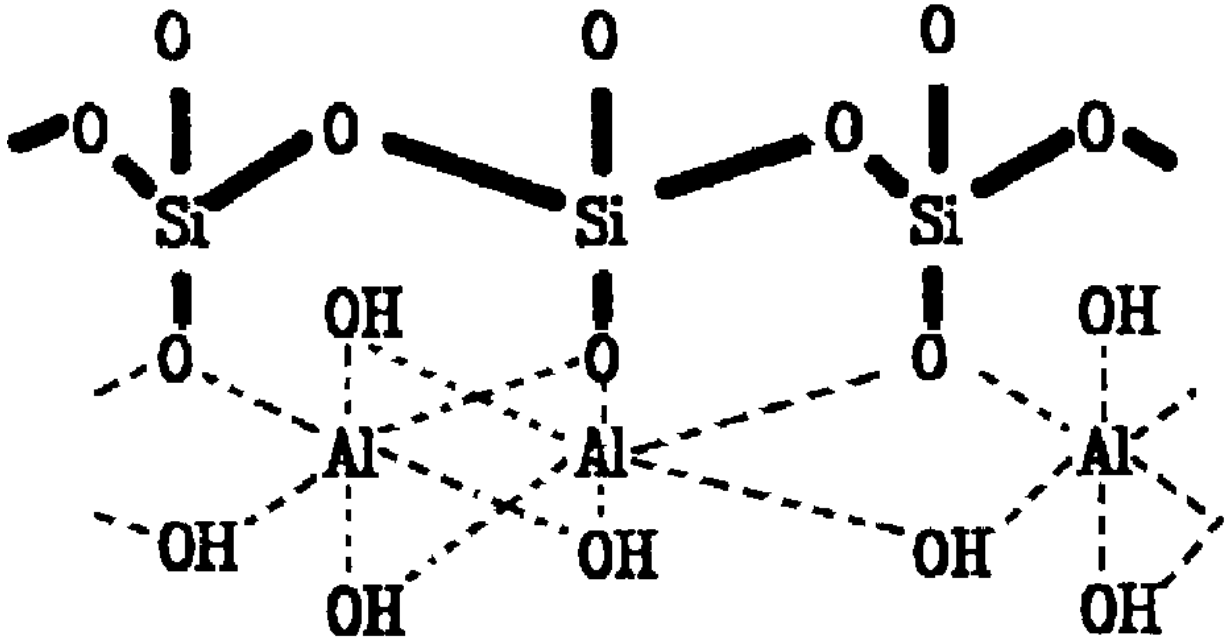

Plastics are dangerous !!
Are organic polymers heat resistant ??

- **No ! NATURE states :**
  - **Only MINERALS provide fire and heat resistance**
- **Target: Inorganic polymers**

Inorganic polymer

Kaolinite $Si_2O_5,Al_2(OH)_4$

Poly(siloxo) chain



Aluminum-hydrate side groups

NEEDS

Low Temp. Reaction as for organic polymers.

Quest for information: WHO?

Scientific Team:

Simone Caillère and Stéphane Henin,
***Museum of Natural History*, Paris.**

C. R. Acad. Sc. Paris, t. 269, p. 1367-1368 (13 octobre 1969) **(1969)** Série D

MINÉRALOGIE. — *Conditions de préparation de l'hydrosodalite à basse température*. Note (*) de M^me^ **Huguette Besson,** M^lle^ **Simonne Caillère** et M. **Stéphane Henin,** transmise par M. Jean Orcel.

$$Si_2O_5,Al_2(OH)_4 + NaOH \longrightarrow Na(\text{-}Si\text{-}O\text{-}Al\text{-}O)n$$

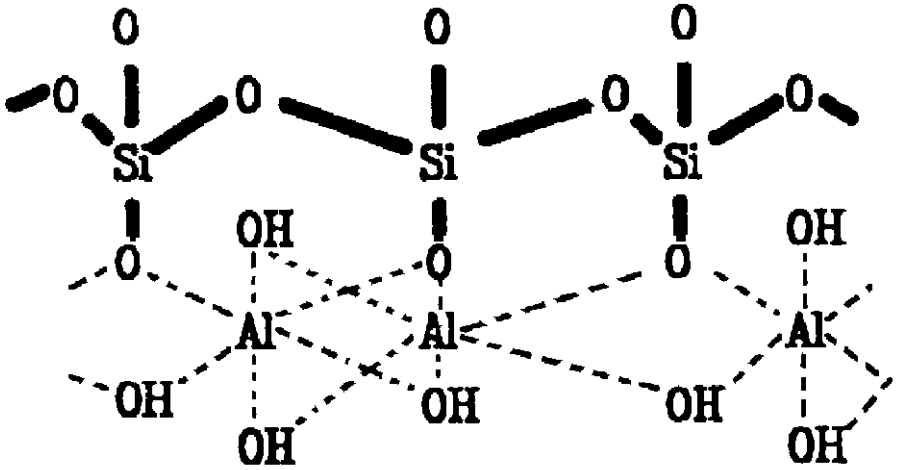
kaolinite **hydrosodalite**

Il faut signaler cependant que W. Borchert et J. Keidel ([6]) en 1949 ont préparé des hydrosodalites plus ou moins riches en sodium dans des conditions différentes. Ces auteurs utilisaient un mélange de kaolinite et de soude chauffé seulement à 100°.

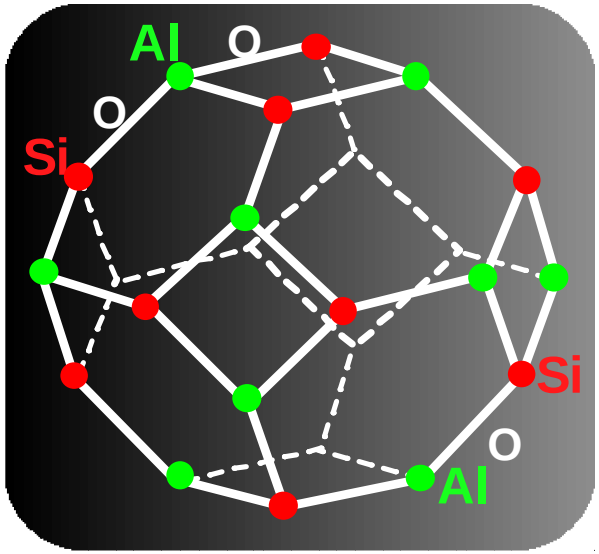
1949

2 D network
sheet polymer

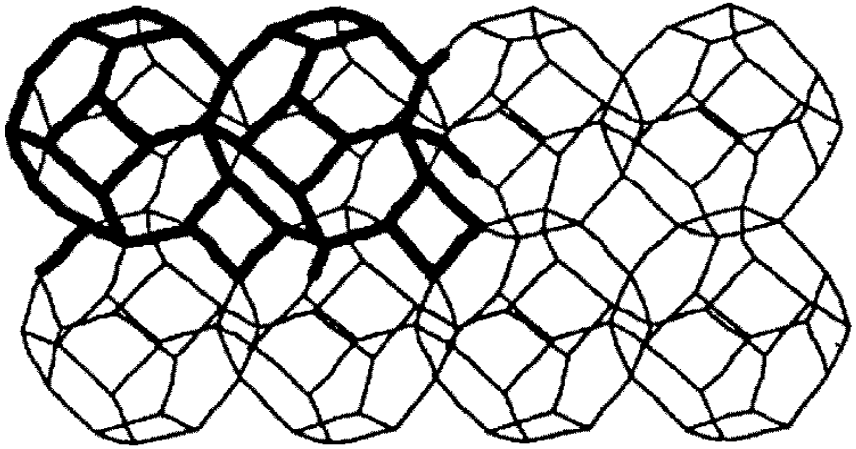
KAOLINITE



polycondensation



b-sodalite cage



3 D network

U.S.S.R. Patent **1964**

193335 BINDER or material for use in the manufacture of building products is produced by treating ground kaolin with a solution of caustic soda of any suitable concentration. The resulting mass can be formed into products which, after drying at 100°C develop a high strength, resistance to moisture and to low temperatures. 29.1.64. as 878827/29-14, BERG, L.G. et al. Kazan Engineering and Building Inst. (17.4.67.) Bul. 6/2.3.67. Class 80b, Int. Cl. C 04b.

Des matériaux non cuits, à base de kaolin, pour les surfaces apparentes de bâtiments

Traduction d'un article de L.G. Berg, B.A. Demidenko, V.I. Remiznikova et N.S. Nizamov, paru dans le numéro 10/1970 de la revue technique soviétique "Stroitel'nye materialy", page 22.

A l'Institut de Génie civil de Kasan, on travaille, depuis quelques années, au développement et aux procédés de fabrication de nouveaux matériaux pour le revêtement des surfaces apparentes de bâtiments. En collaboration avec l'Université d'Etat V.I. Oulyanov-Lénine de Kasan, on a étudié les possibilités de fabrication de matériaux de revêtement non cuits. Il en résulte la proposition d'un procédé basé sur la réaction de matériaux argileux avec les lessives.

DEUTSCHES REICH

AUSGEGEBEN AM
20. JULI 1934

1934

REICHSPATENTAMT

PATENTSCHRIFT

№ 600327

KLASSE 80b GRUPPE 12 01

O 19880 VI/80b

Tag der Bekanntmachung über die Erteilung des Patents: 28. Juni 1934

Niels Olsen in Frederiksberg, Dänemark

Verfahren zum Härten von Ton bei niedriger Temperatur

Patentiert im Deutschen Reiche vom 28. Mai 1932 ab

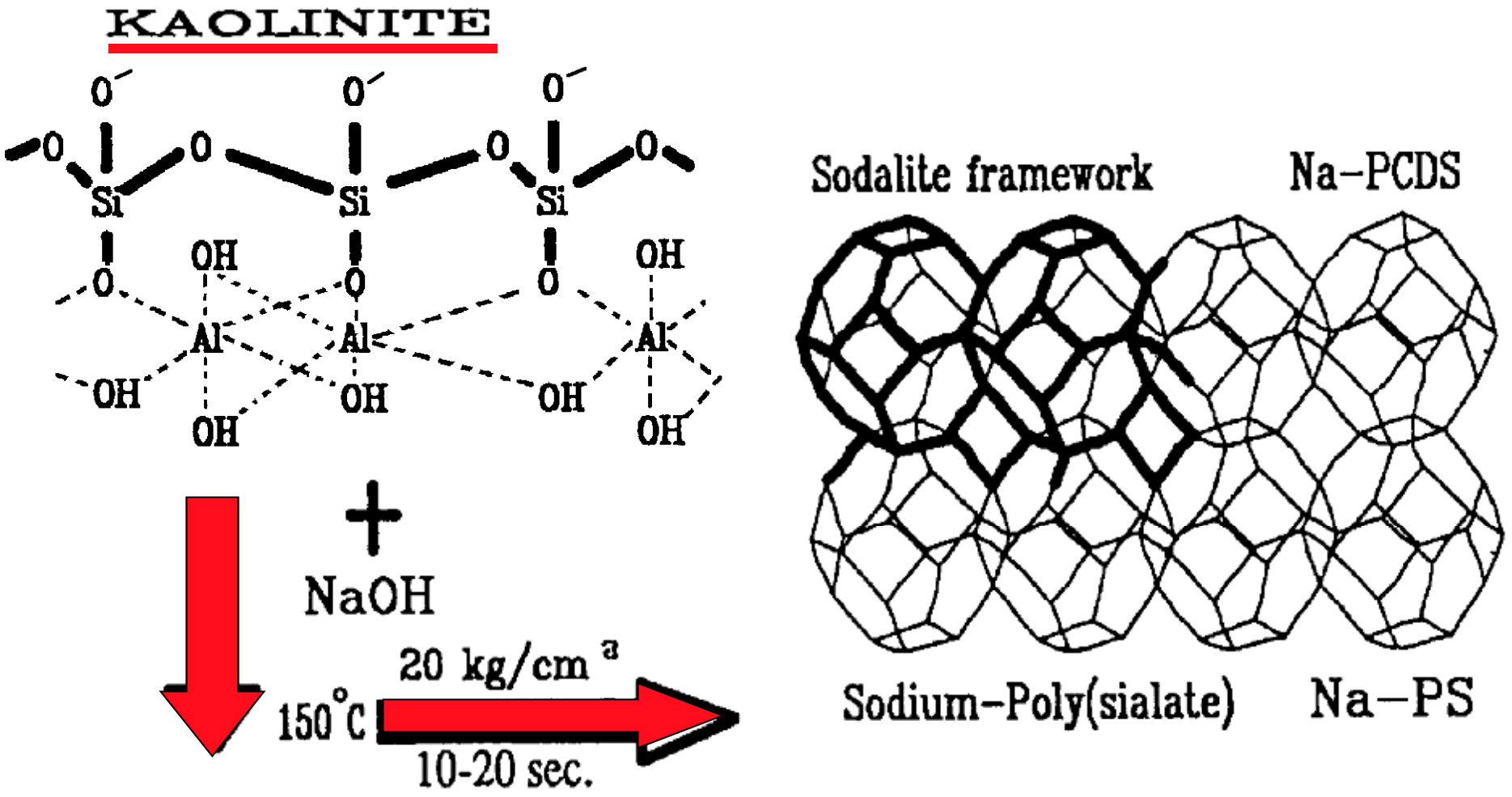
1932

Als Ausführungsbeispiel des Verfahrens kann folgendes dienen: Der Ton wird auf einen Kollergang gebracht, wo er mit einer 6 bis 8 Teilen NaOH für je 100 Teile trockenen Tons entsprechenden Menge einer Natriumhydroxydlösung geknetet wird. Der Ton kann nun durch Erwärmen auf zwischen 150 und 500° getrocknet und gehärtet werden.

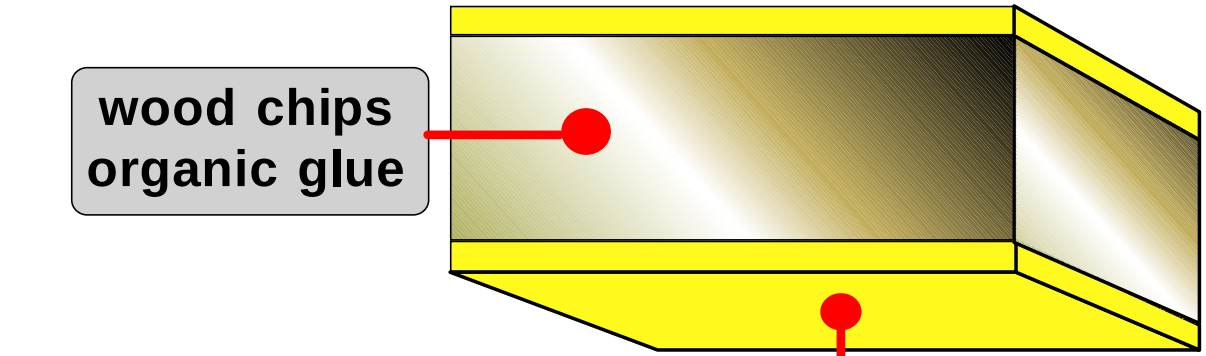
Polyconsensation

like

phenolic resin



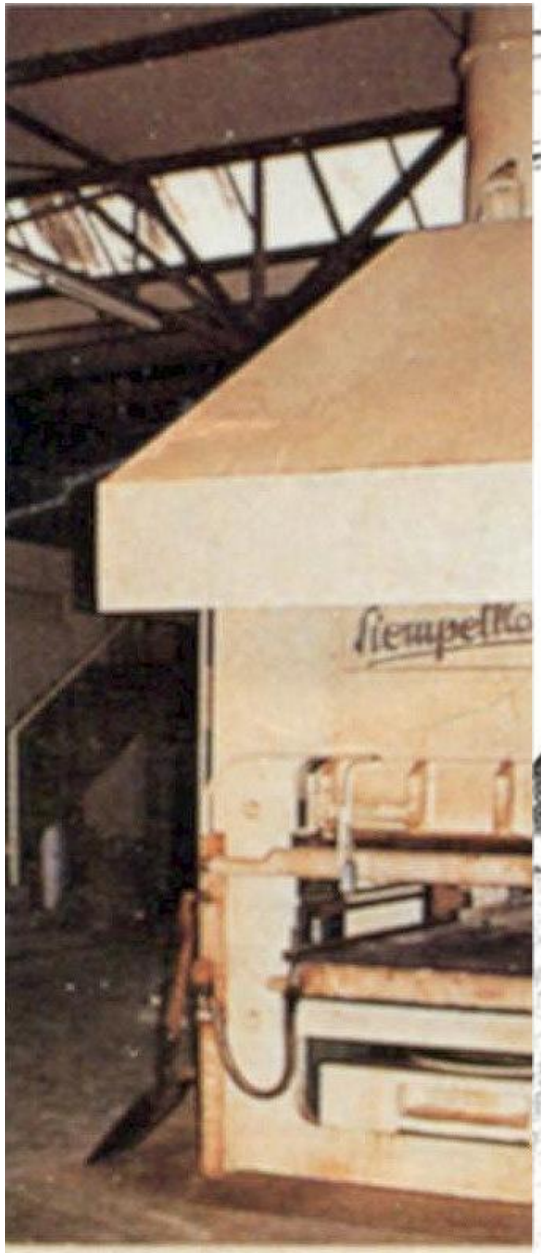
SILIFACE Process

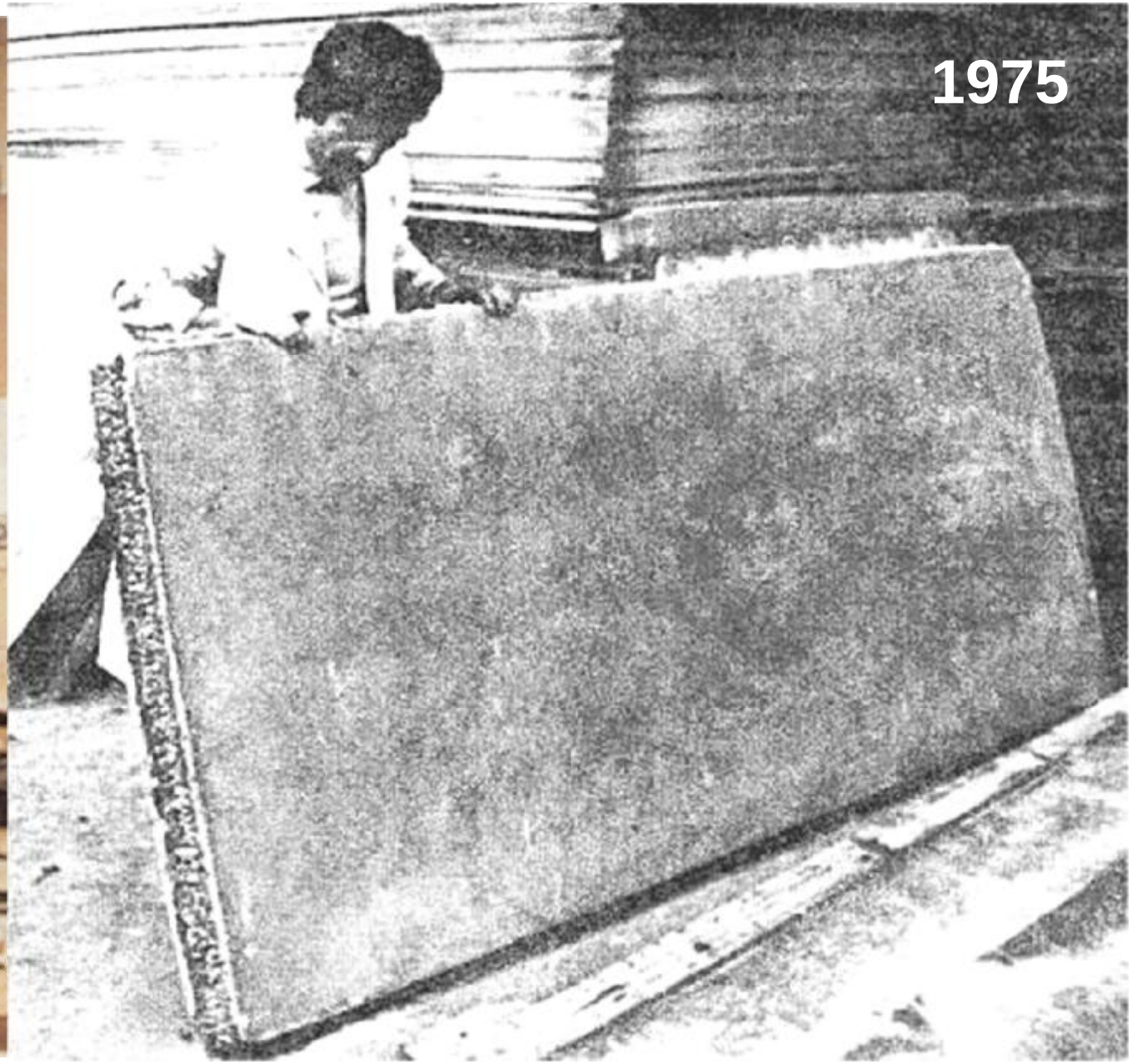


wood chips
organic glue

1 step process
heated press
at 150°C (300°F)
5-10 minutes

Silico-Aluminate facing
Na-PS

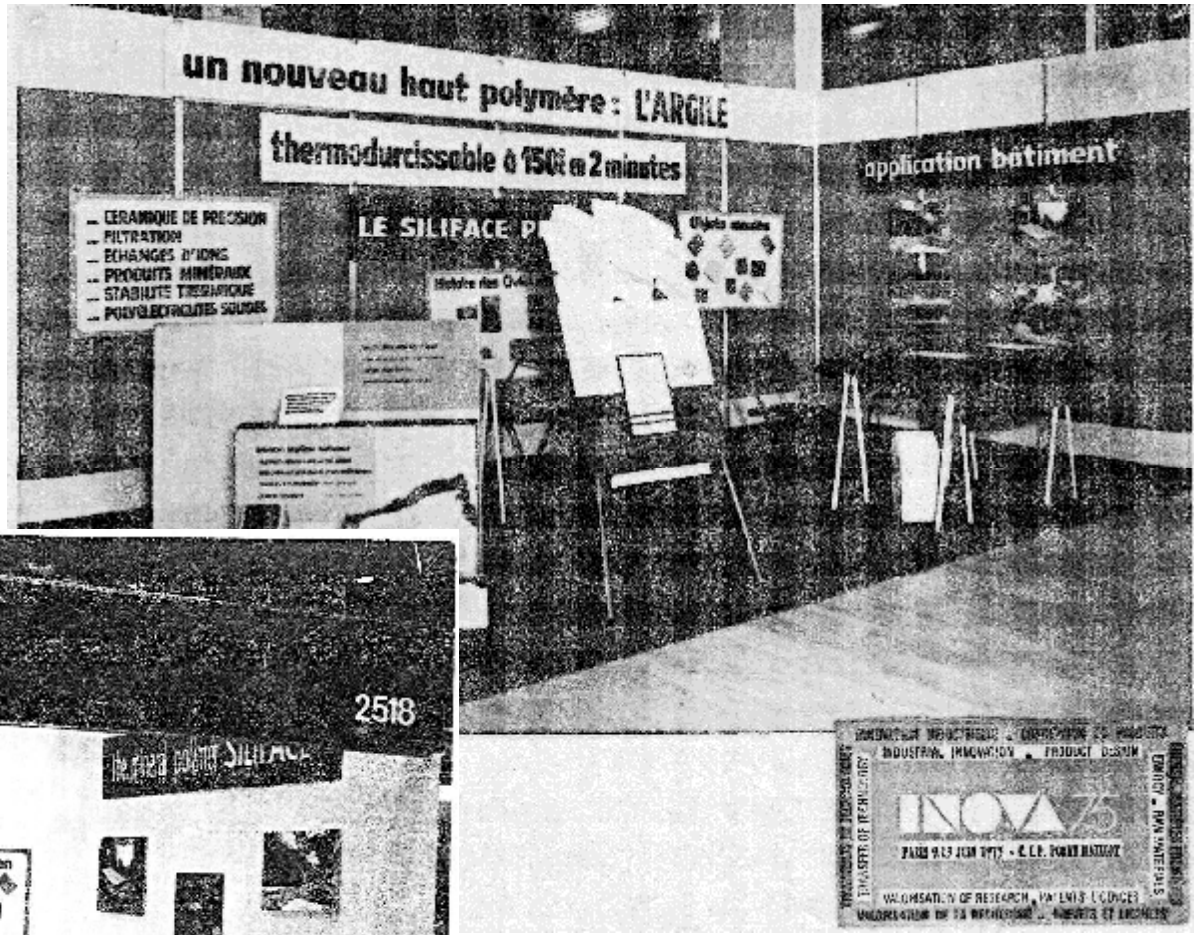


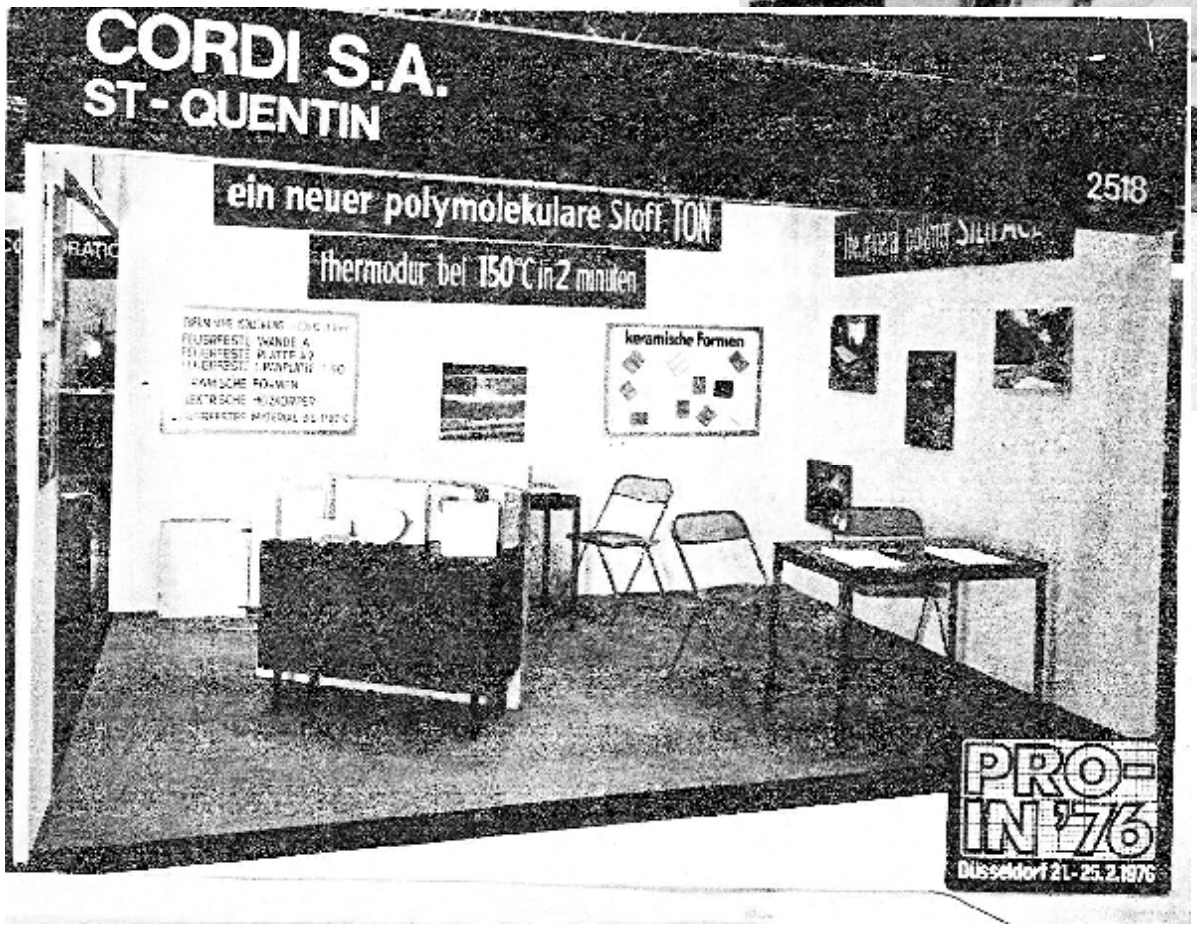

1975

A new polymer :

Clay !

Paris 1975





Düsseldorf 1976

clay = polymer

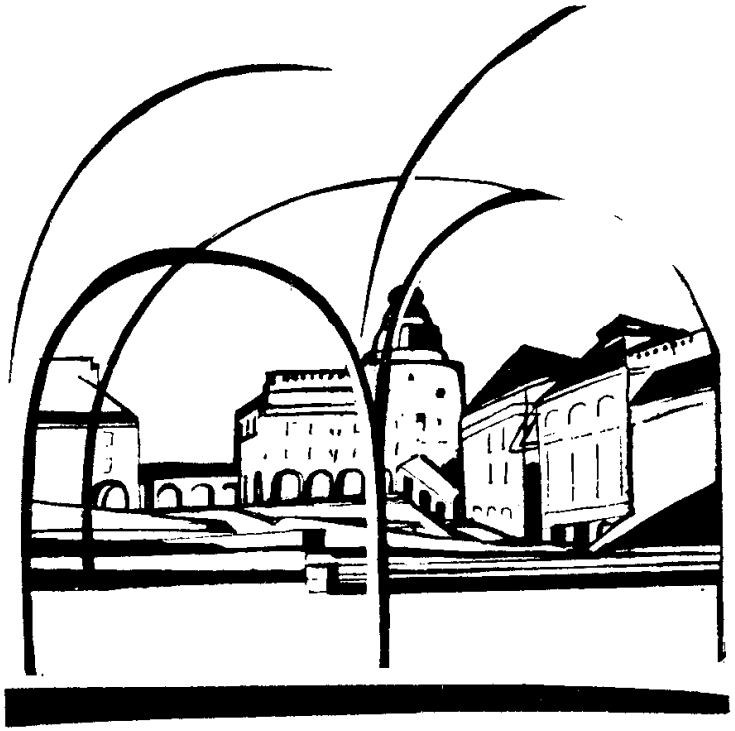
misunderstanding !!

Polymer terminology !

I.U.P.A.C. symposium Stockholm Sept. 1976

PROGRAMME OF THE IUPAC SYMPOSIUM ON
LONG-TERM PROPERTIES OF POLYMERS AND
POLYMERIC MATERIALS

Stockholm, August 30 - September 1,1976



ORGANIZED BY

THE DEPARTMENT OF POLYMER TECHNOLOGY

THE ROYAL INSTITUTE OF TECHNOLOGY

STOCKHOLM SWEDEN

I.U.P.A.C. 1976

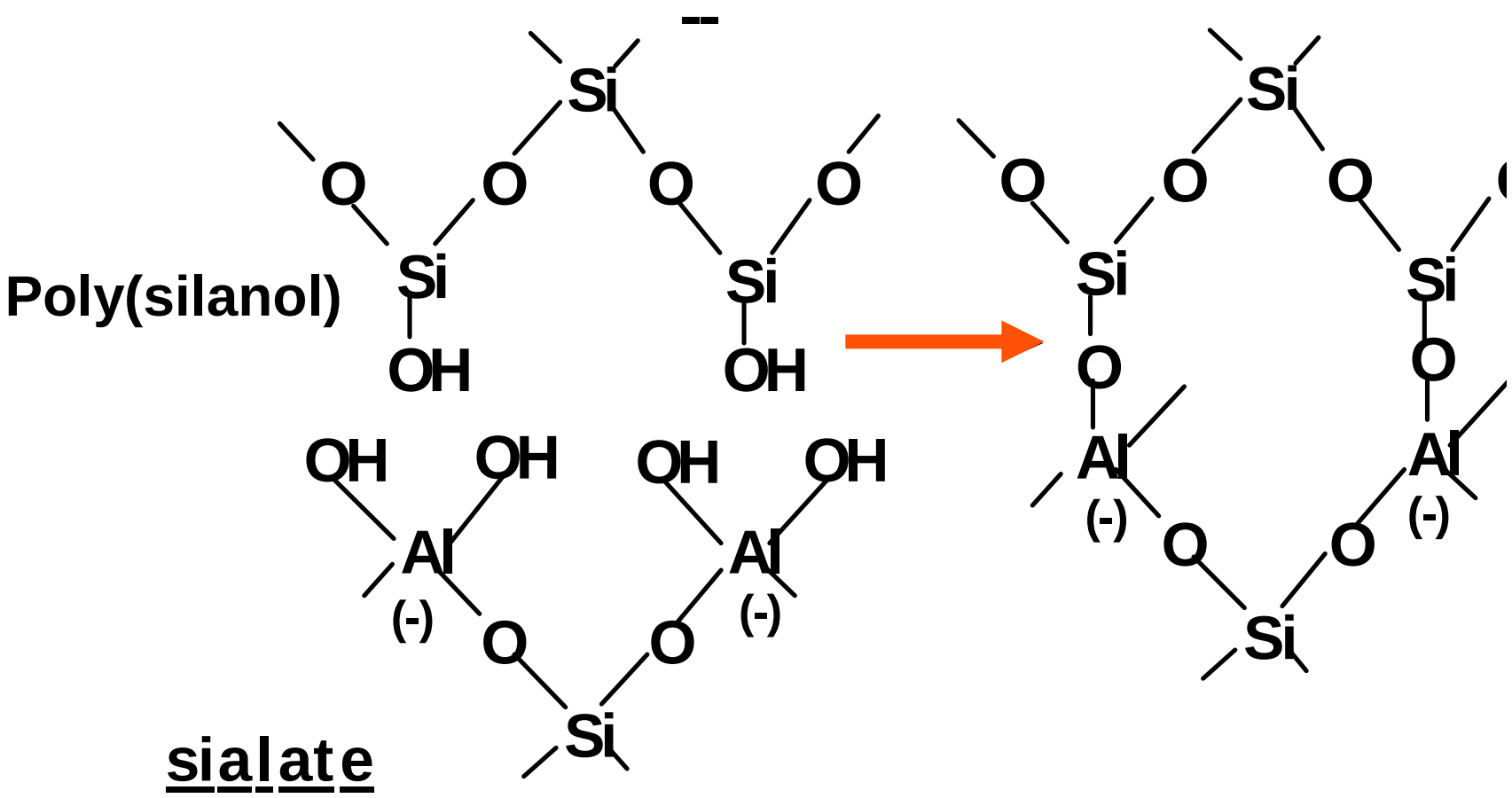
WEDNESDAY, SEPTEMBER 1

TOPIC III, NEW POLYMERS OF HIGH STABILITY

14.30 - SOLIDPHASE SYNTHESIS OF A MINERAL BLOCKPOLYMER BY LOW TEMPERATURE POLYCONDENSATION OF ALUMINOSILICATE POLYMERS

by J. Davidovits (Cordi S.A., Saint-Quentin, France

1977-1978 **Poly(sialate) block polymers**



Mean linear expansion
20-700 deg.C

Fe	**0.96%**
Steatite	**0.80%**
Cermet	**0.70%**
Iridium	**0.50%**
Mulite	**0.40%**
Mo	**0.45%**
Silicium nitrid	**0.25%**
SILIFACE COR 70	**0,13%**

Mechanical properties: OK

Thermal properties: OK

Molding 120 deg.C: OK

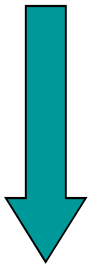
post-treatement 450 deg.C: OK

H_2O absorption: 0.3%: weak

1978

Kaolinite

$Si_2O_5,Al_2(OH)_4$



- $2H_2O$

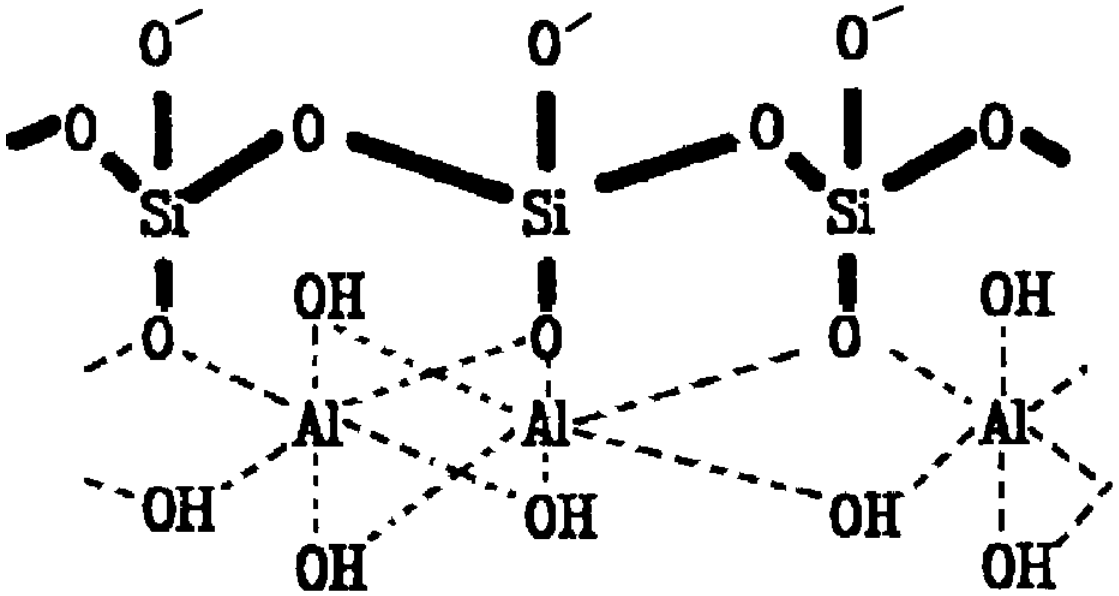
Metakaolin

Si_2O_5,Al_2O_2

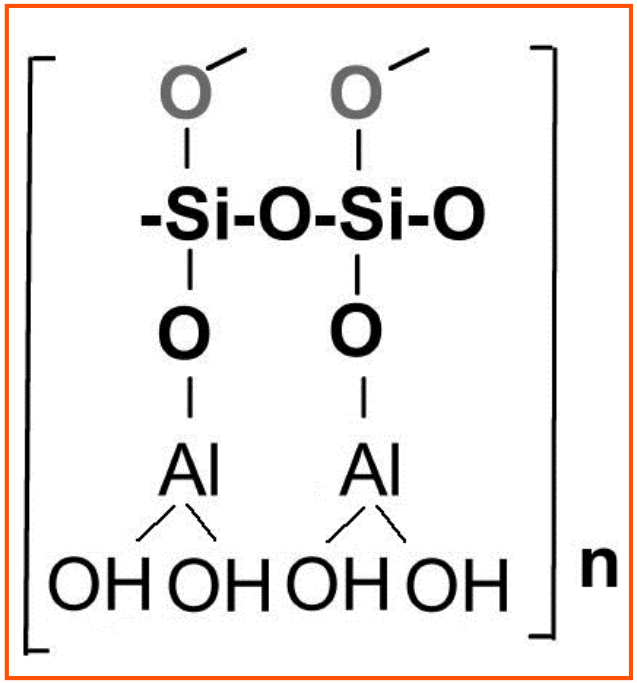
Alumino-silicate Oxide

KANDOXI

MK-750



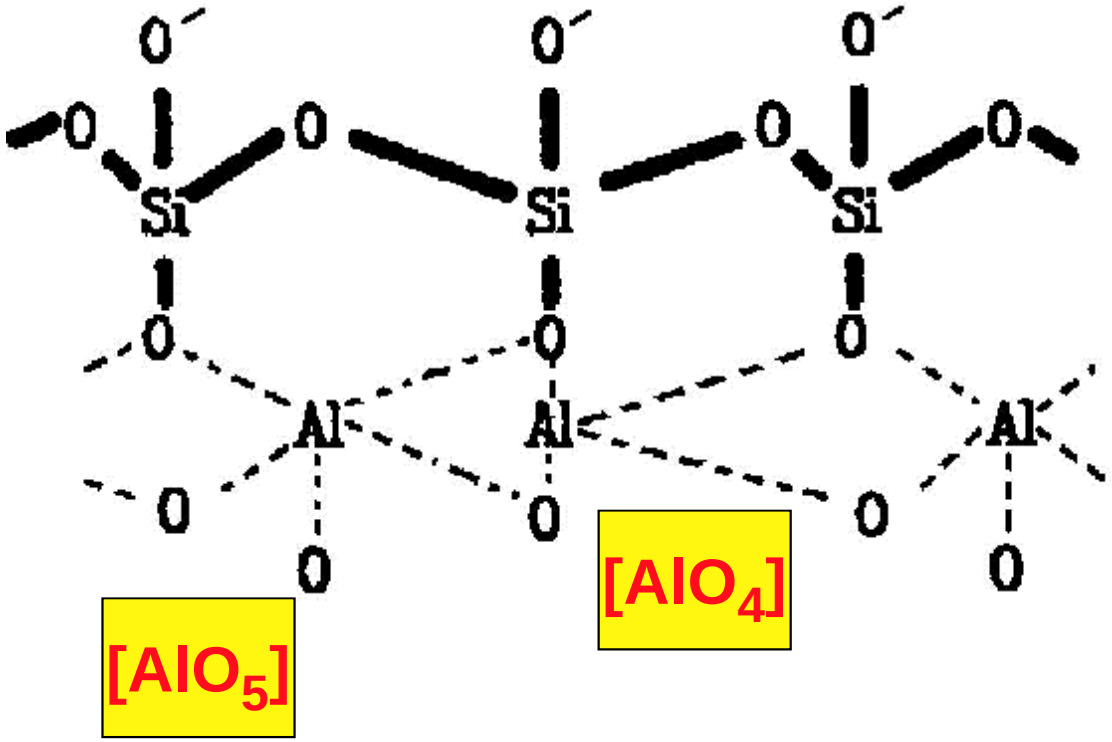
$[Al]^{VI}$

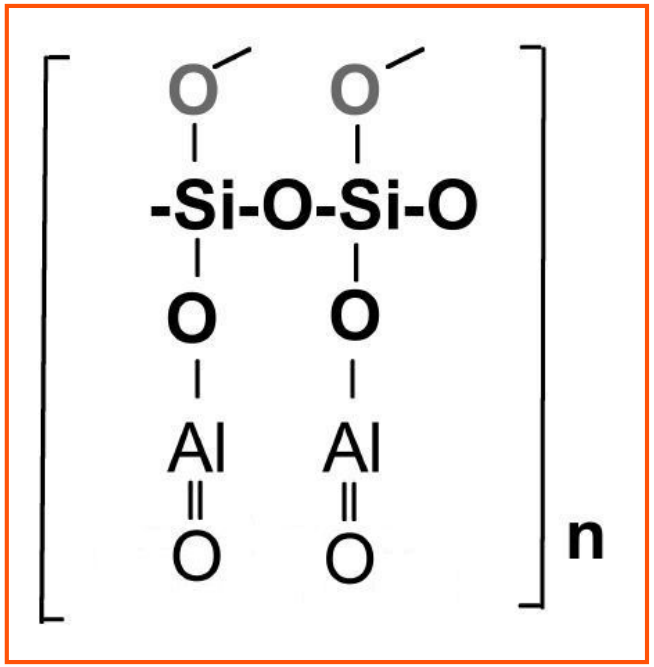


Kaolinite

$2SiO_2.Al_2O_3.2H_2O$

$Si_2O_5,Al_2(OH)_4$





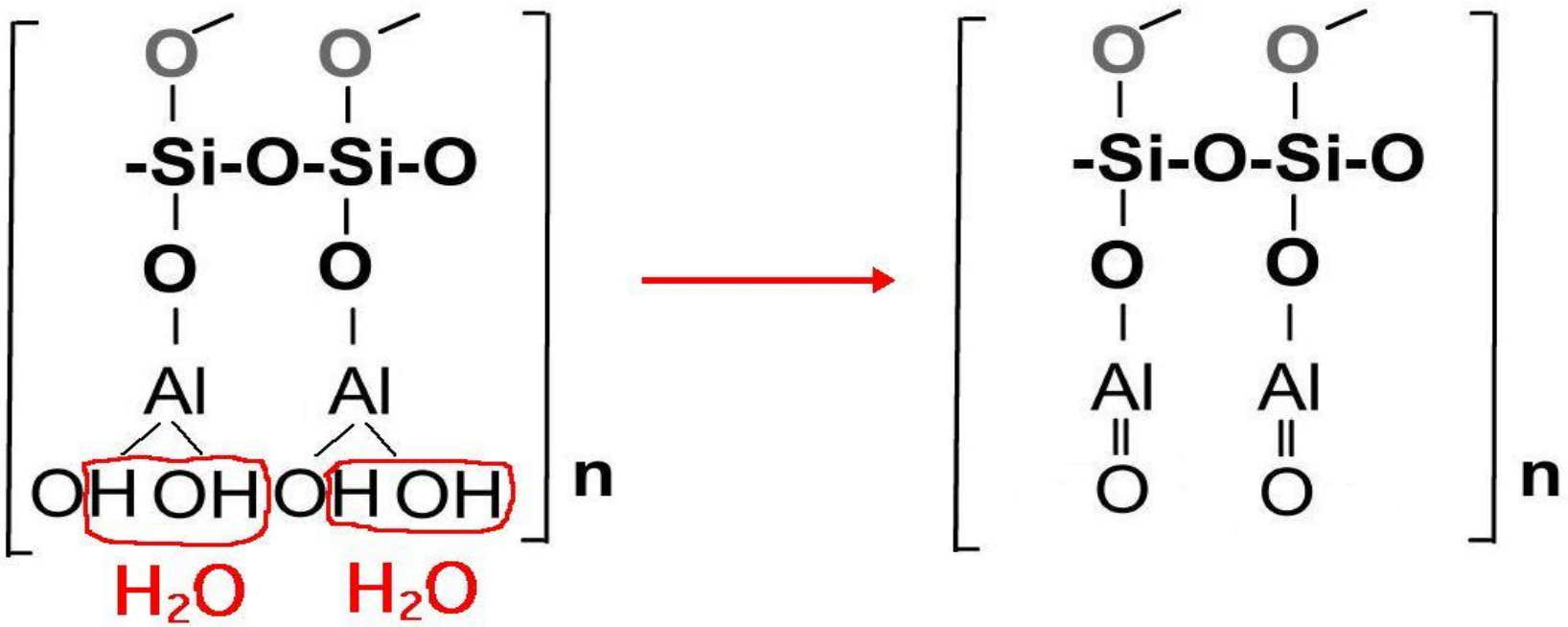
Metakaolin MK-750

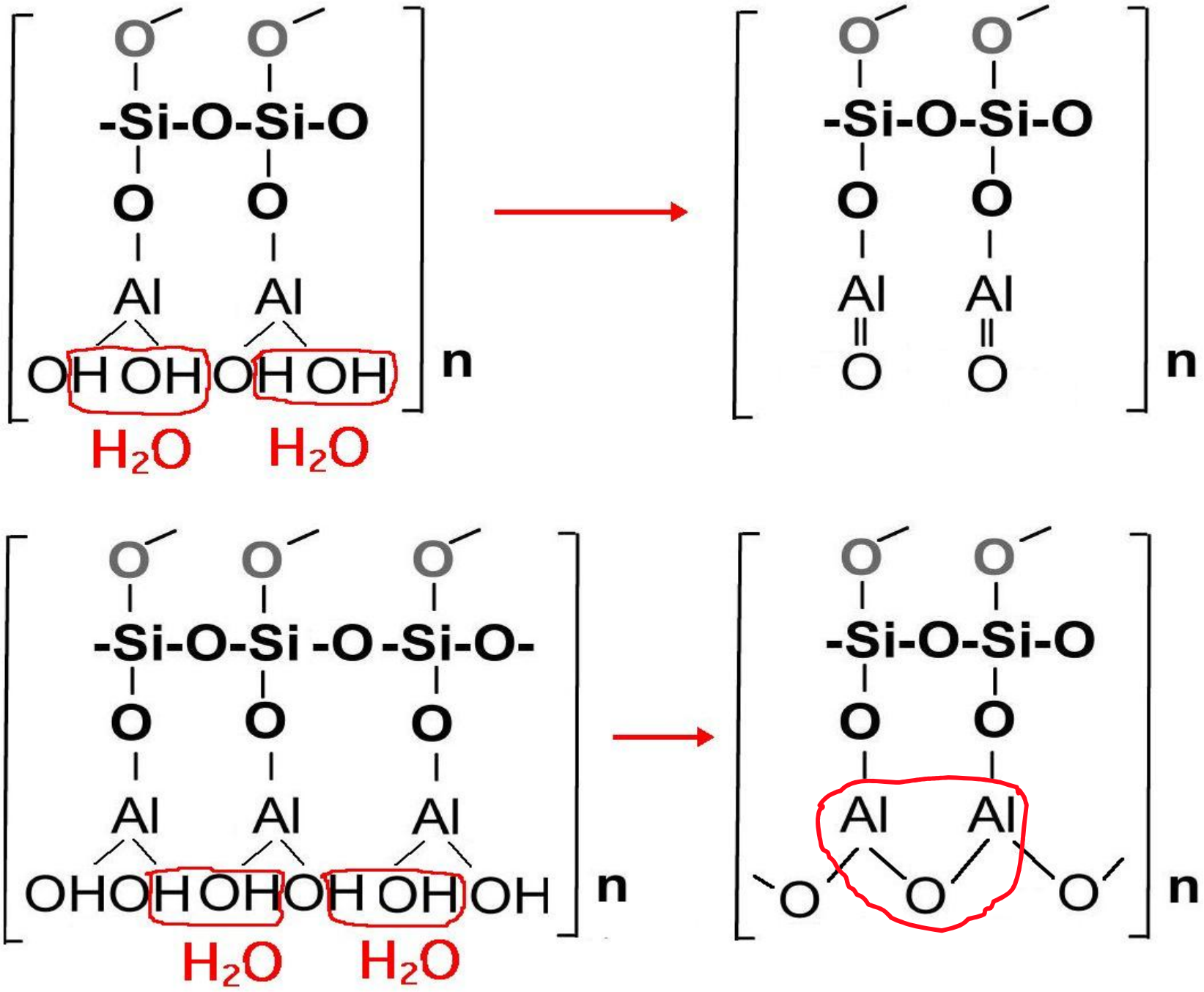
$2SiO_2.Al_2O_3$

Si_2O_5,Al_2O_2

Alumino-silicate Oxide

Poly(siloxo)-aluminum-oxide


-Si-O-Si-O
O O
Al Al
OH OH OH OH
n
H2O H2O
-Si-O-Si-O
O O
Al Al
O O
n


-Si-O-Si-O
O
Al
OH OH OH OH
n
H2O H2O
-Si-O-Si-O
O
Al
O
n
-Si-O-Si -O -Si-O-
O
Al
OHOHOHOH OH OH
n
H2O H2O
-Si-O-Si-O
O
Al
O
n

1977

1st mineral polymer resin

$$\begin{array}{l} | \\ \text{-Si-O-Al=O} \\ | \end{array} + \text{nSiO}_2 + \text{(Na,K)OH}$$

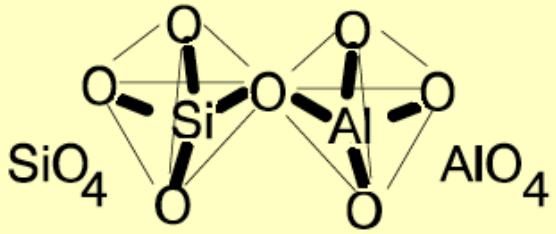
MK-750 **soluble silicate**


73

1979 Geopolymer Terminology

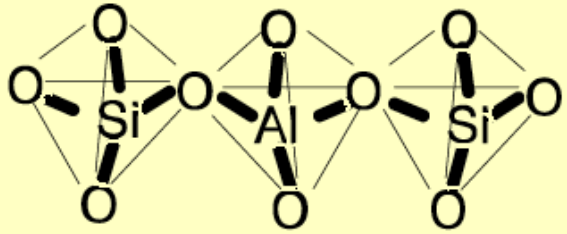
Si:Al = 1:1

Poly(sialate)
(-Si-O-Al-O-)



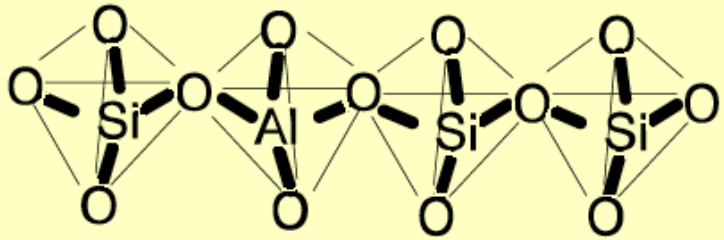
Si:Al = 2:1

Poly(sialate-siloxo)
(-Si-O-Al-O-Si-O-)

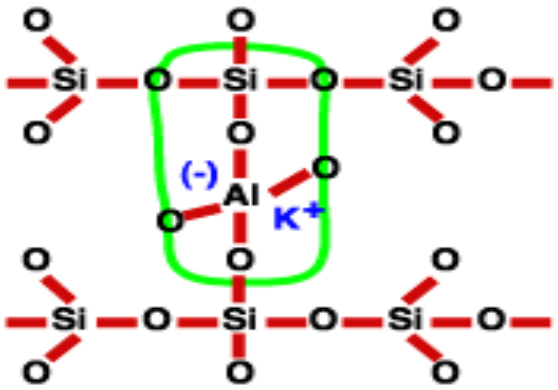


Si:Al = 3:1

Poly(sialate-disiloxo)
(-Si-O-Al-O-Si-O-Si-O-)



Si:Al >3:1 **Sialate link**



Geopolymers are

Polymers,

processed like

organic polymers

Yet,

GEO- polymers

Fire and heat resistant

1979

Foundation of the GEOPOLYMER INSTITUTE,

Saint-Quentin, France

Non for profit scientific association

d d d

The word « geopolymer » : public domain

PACTEC conference, Los Angeles, USA

d d d

Presentation of my archaeological researches at the 2nd International Congress of Egyptologists, Grenoble, France

Cement applications !

1983

U.S.A.

Lone Star Industries

Geopolymer cement, PYRAMENT

(11 years after begin of research, 1972)

d d d

Barry University, Miami, Florida

Institute for Applied Archaeological Sciences

1st PYRAMENT patent

United States Patent [19]

Davidovits et al.

[11] Patent Number: 4,509,985

[45] Date of Patent: Apr. 9, 1985

[54] EARLY HIGH-STRENGTH MINERAL POLYMER

[75] Inventors: Joseph Davidovits, Saint-Quentin, France; James L. Sawyer, Friendswood, Tex.

[73] Assignee: Pyrament Inc., Houston, Tex.

[21] Appl. No.: 582,279

[22] Filed: Feb. 22, 1984

1984

[51] Int. Cl.[3] C04B 19/04

[52] U.S. Cl. 106/84; 106/85; 106/117

[58] Field of Search 106/84, 85, 117

[56] References Cited

U.S. PATENT DOCUMENTS

4,349,386 9/1982 Davidovits 106/85

Primary Examiner—James Poer

Attorney, Agent, or Firm—McAulay, Fields, Fisher, Goldstein & Nissen

[57] ABSTRACT

An early high-strength mineral polymer composition is formed of a polysialatesiloxo material obtained by adding a reactant mixture consisting of alumino-silicate oxide (Si_2O_5,Al_2O_2) with the aluminum cation in a four-fold coordination, strong alkalis such as sodium hydroxide and/or potassium hydroxide, water, and a sodium/-potassium polysilicate solution; and from 15 to 26 parts, by weight, based upon the reactive mixture of the polysialatesiloxo polymer of ground blast furnace slag. Sufficient hardening for demolding is obtained in about 1 hour with this composition.

6 Claims, No Drawings

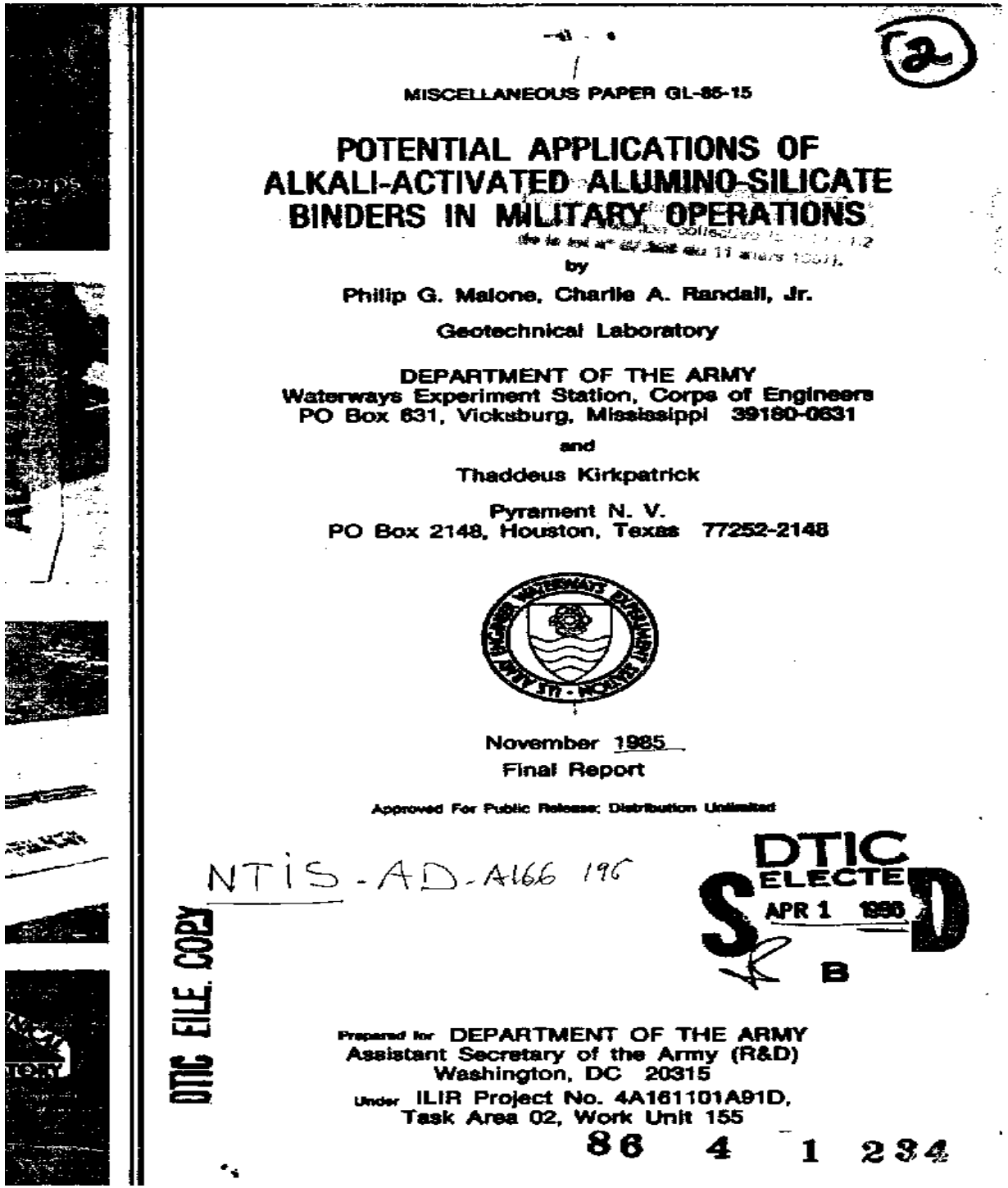
Lone Star/PYRAMENT cement

Los Angeles: a crew begins placing concrete.

New York: a Boing departs

1 hour	4 hours	6 hours
Strong enough to walk on	Strong enough to drive on	Ready for the weight of a commercial jet

Start March 1983 / all rights sold to Lone Star Ind. Oct. 1989



MISCELLANEOUS PAPER GL-85-15

POTENTIAL APPLICATIONS OF ALKALI-ACTIVATED ALUMINO-SILICATE BINDERS IN MILITARY OPERATIONS

by

Philip G. Malone, Charlie A. Randall, Jr.

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

and

Thaddeus Kirkpatrick

Pyrament N. V.
PO Box 2148, Houston, Texas 77252-2148

November 1985
Final Report

Approved For Public Release; Distribution Unlimited

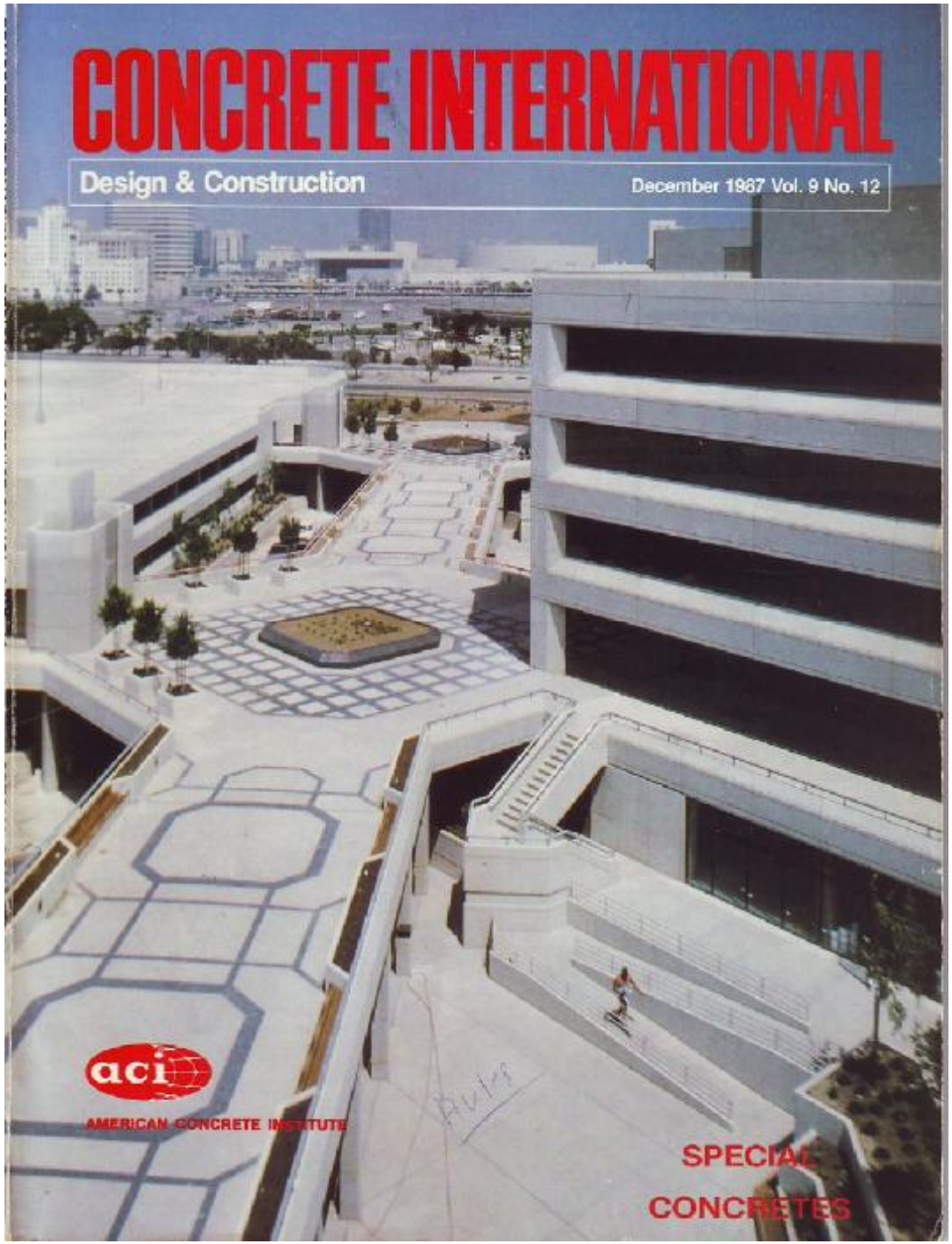
1985-1986

Testing of geopolymer cement PYRAMENT by US ARMY CORPS ENGINEERS

Study on various alkali-activated systems, V. Glukosvsky

1987

1st paper on geopolymer concrete



Concrete International, dec. 1987

Geopolymeric concrete may be a key to increased durability

Ancient and Modern Concretes: What Is the Real Difference?

by Joseph Davidovits

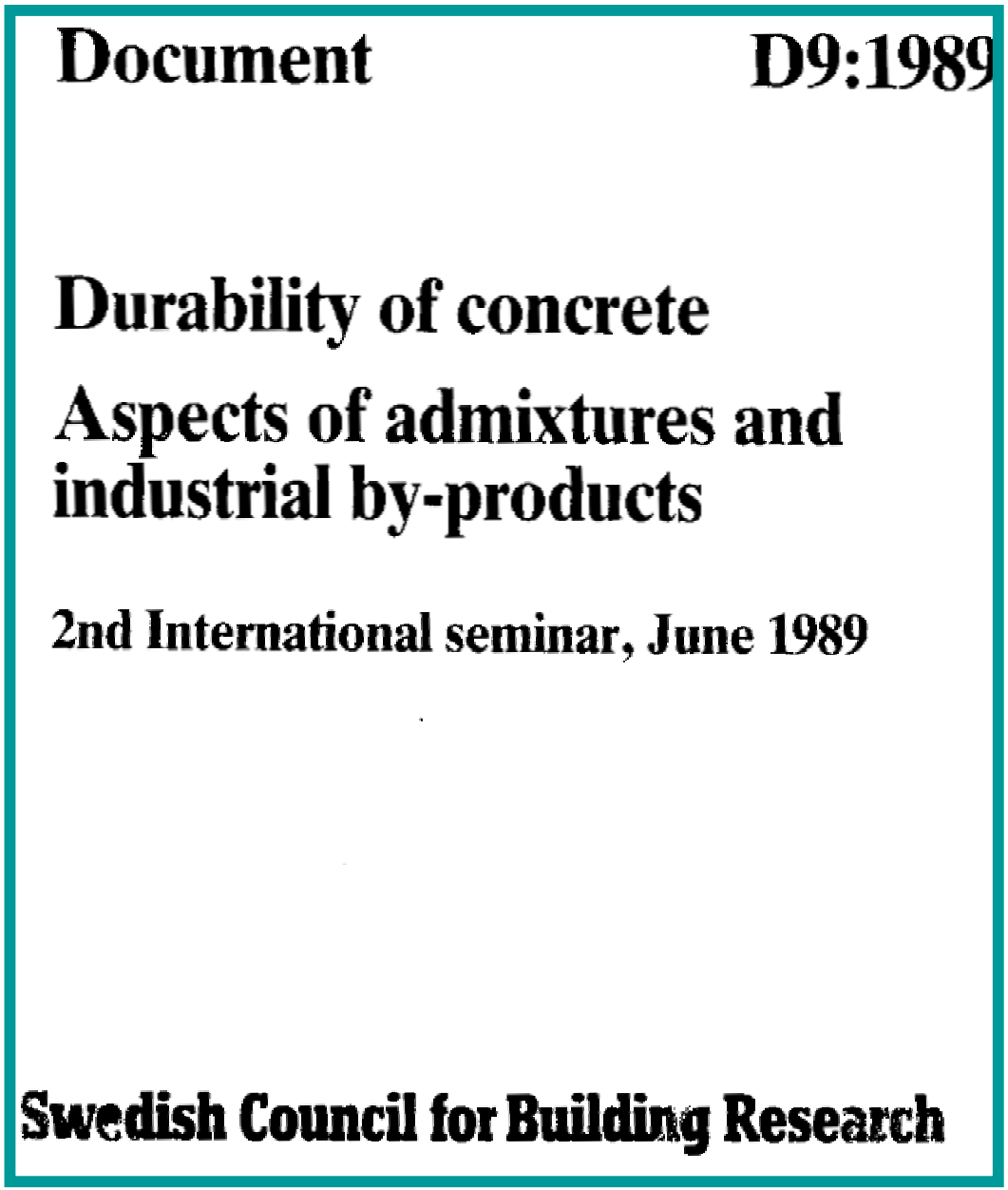
Many observers of ancient architecture are struck by the vast difference in quality between original structures and more recent repairs. Recent studies have attempted to determine why ancient mortars and concretes are so much more durable than their modern counterparts. Many of these materials have been found to be geopolymeric concrete which has been replicated and may prove to be an appropriate concrete for many modern purposes.

magazine[2] dealt with a fascinating idea which would put the origin of concrete much earlier....According to this theory...to build a pyramid ....Egyptian workers could have carried crushed limestone to the work site in buckets, mixed it with Nile River silt for the needed aluminum and silicon binder, and added salts available locally as catalysts to make the solution alkaline. They could have dumped the ingredients into wooden molds and a few hours in the desert heat would have dried the mixture

same conditions. Under certain climatic conditions, some portland cement structures that are only ten years old are being severely eroded, whereas two thousand year old cement in structures in the same locations remains unaffected.

Unfortunately, only cements and mortars of surviving monuments can be investigated, since monu-

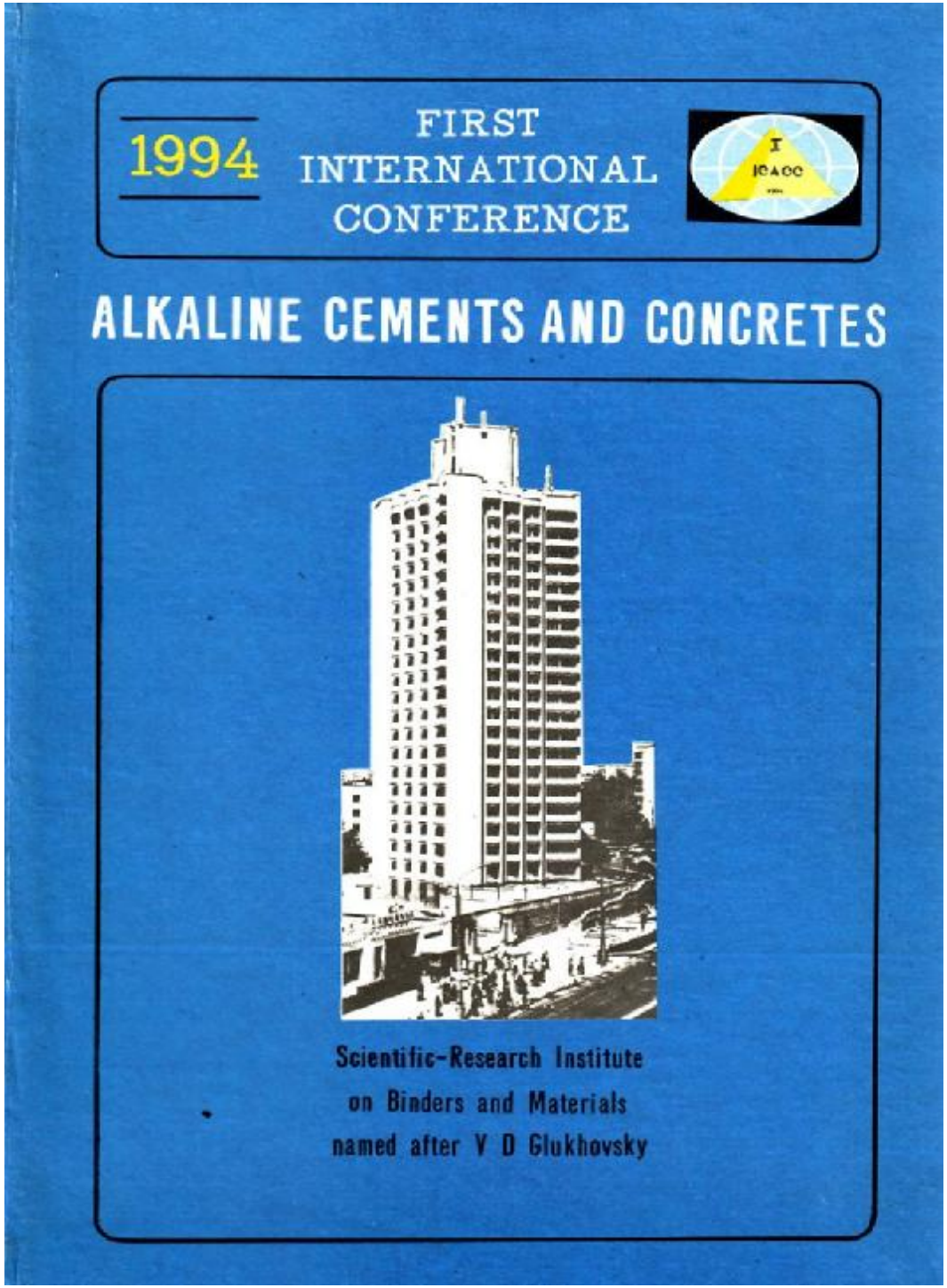
1989



Last paper by
V.D. Glukhovsky

Title:
Ancient, Modern and Future Concretes

based on
J. Davidovits,
Concrete International
paper, 1987



1994

KIEV

alkali-activated
vs
geopolymer

metakaolin
Soil-silicate cement
Geo-cement

Construction

1983

Geopolymer Cement

1987

1990

Toxic + Radioactive

Waste Management

Global Warming

CO_2 Emission Mitigation

Development
of
alumino-silicate materials !

	Zeolite SiO_2, $Al_2(OH)_3$	Alkali-activation *slag*	Hydrosodalite *kaolin*	Geopolymer *MK-750*

	Zeolite *SiO_2, $Al_2(OH)_3$*	Alkali-activation *slag*	Hydrosodalite *kaolin*	Geopolymer *MK-750*
1930			1932 : Olsen (NL)	

	Zeolite SiO_2, $Al_2(OH)_3$	Alkali-activation *slag*	Hydrosodalite *kaolin*	Geopolymer *MK-750*
1930			1932 : Olsen (NL)	
1940	1945: Barrer (GB)	1940: Purdon (BE)	1949 : Borchert - Keidel (GER)	

	Zeolite SiO_2, $Al_2(OH)_3$	Alkali-activation *slag*	Hydrosodalite *kaolin*	Geopolymer *MK-750*
1930			1932 : Olsen (NL)	
1940	1945: Barrer (GB)	1940: Purdon (BE)	1949 : Borchert - Keidel (GER)	
1950	1956: Milton (US)	1953: Trief (US) 1957: Glukhovsky (UKR) *Soil-silicate-concrete*		

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1960			1963: Howell (US) 1964: Berg, (USSR)	

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1960			1963: Howell (US) 1964: Berg, (USSR)	
1970			1972: Davidovits (FR) *Siliface*	1976: Davidovits *IUPAC* 1979: Davidovits *Geopolymer*

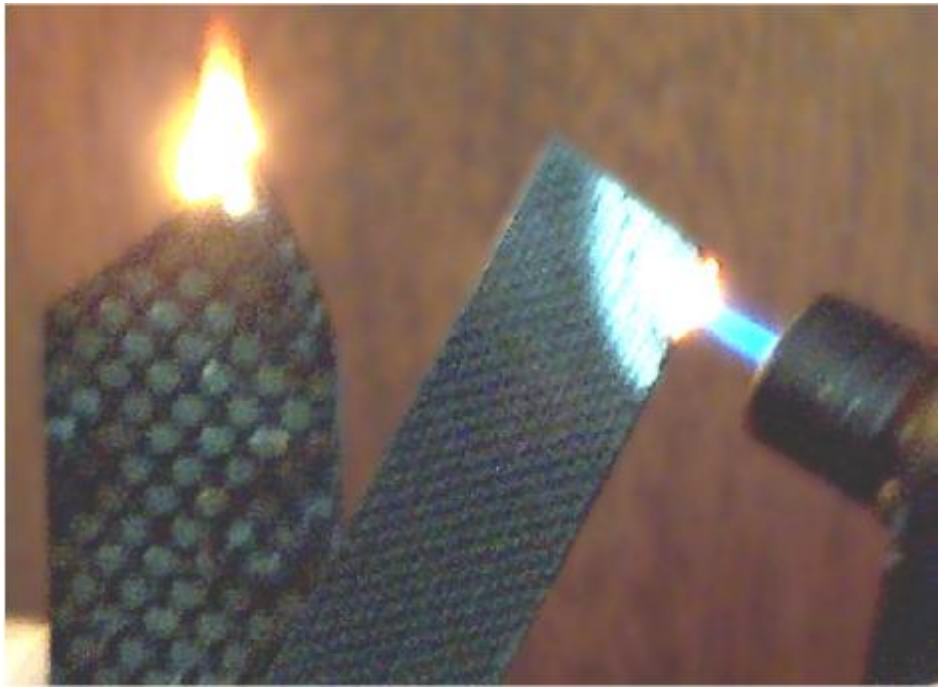
High-tech applications !

1986

Ceramic-Ceramic composite material and production method.

FR 2.604.994: 14/10/1986

Nicolas Davidovits, Michel Davidovics, Joseph Davidovits



A carbon-epoxy composite (left) is burning while a Carbon-Geopolymer Composite still resists a 1200 deg.C fire

Si:Al = 3:1

(K)-(Si-O-Al-O-Si-O-Si-O-)

(K)-poly(sialate-disiloxo)

Fire-proof geopolymeric panels for thermal protection

FR 2.659.963: 20/03/1990

J. Davidovits, M. Davidovics, N. Davidovits

Geopolymeric fluoro-alumino-silicate binder

FR 2.659.320: 07/03/1990

Method for obtaining an early high-strength geopolymeric matrice for the impregnation of composite materials

FR 2.666.328: 04/09/1990

Process for obtaining a geopolymeric alumino-silicate

FR 2.671.344: 03/01/1991

Alkaline aluminosilicate geopolymeric matrix for composite materials with fibre reinforcement

EP 0. 815.064; 15/03/1995


Rafale A

1994-2000 Aircraft cabin safety project

RESEARCH AND DEVELOPMENT

Airport & Aircraft Safety R&D Division

Federal Aviation Administration

HIGHLIGHTS

1997

U.S.A.

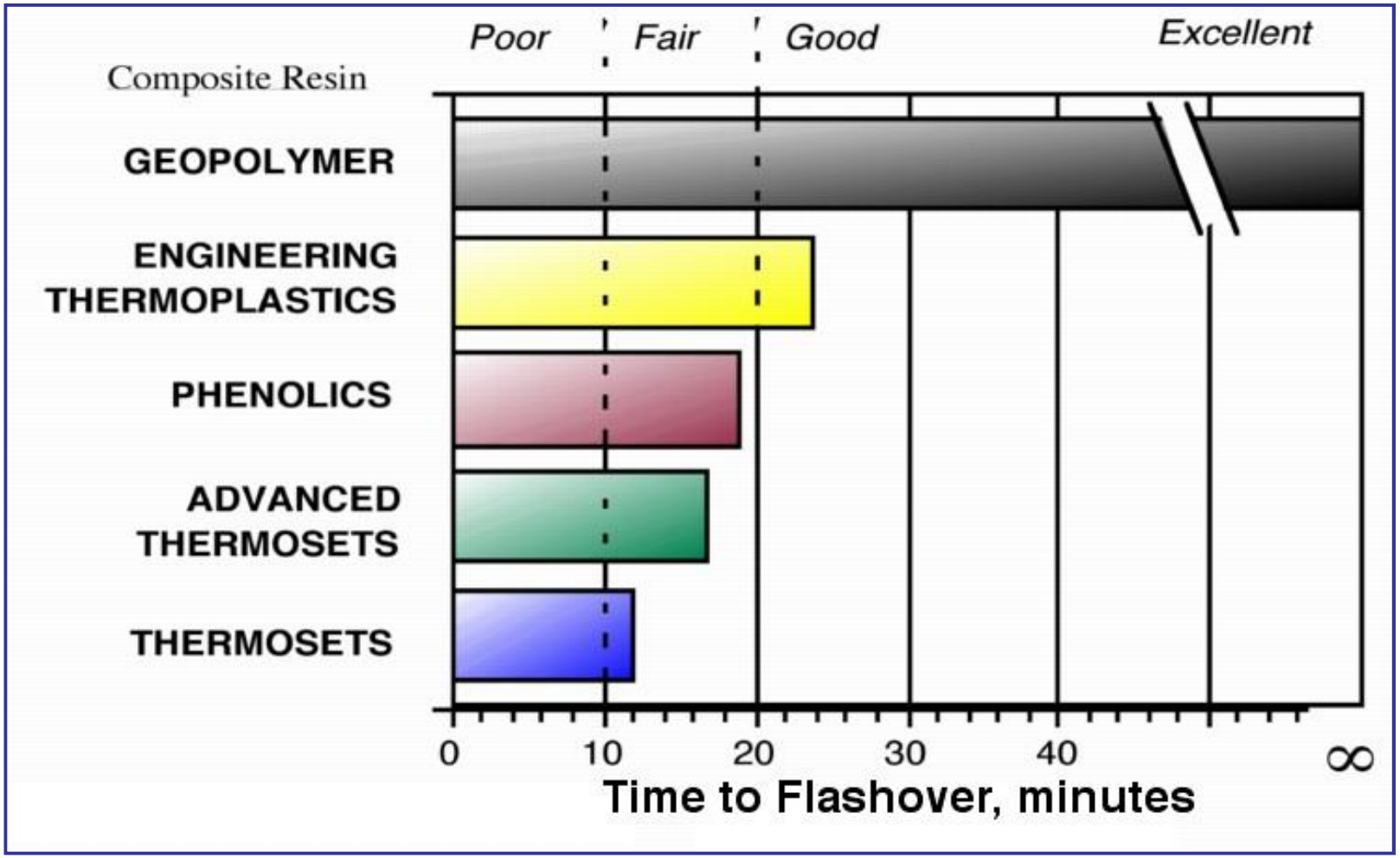
Federal Aviation Administration, F.A.A.

Rutgers
The State University of New Jersey

cordi-géopolymère

Saint-Quentin, France

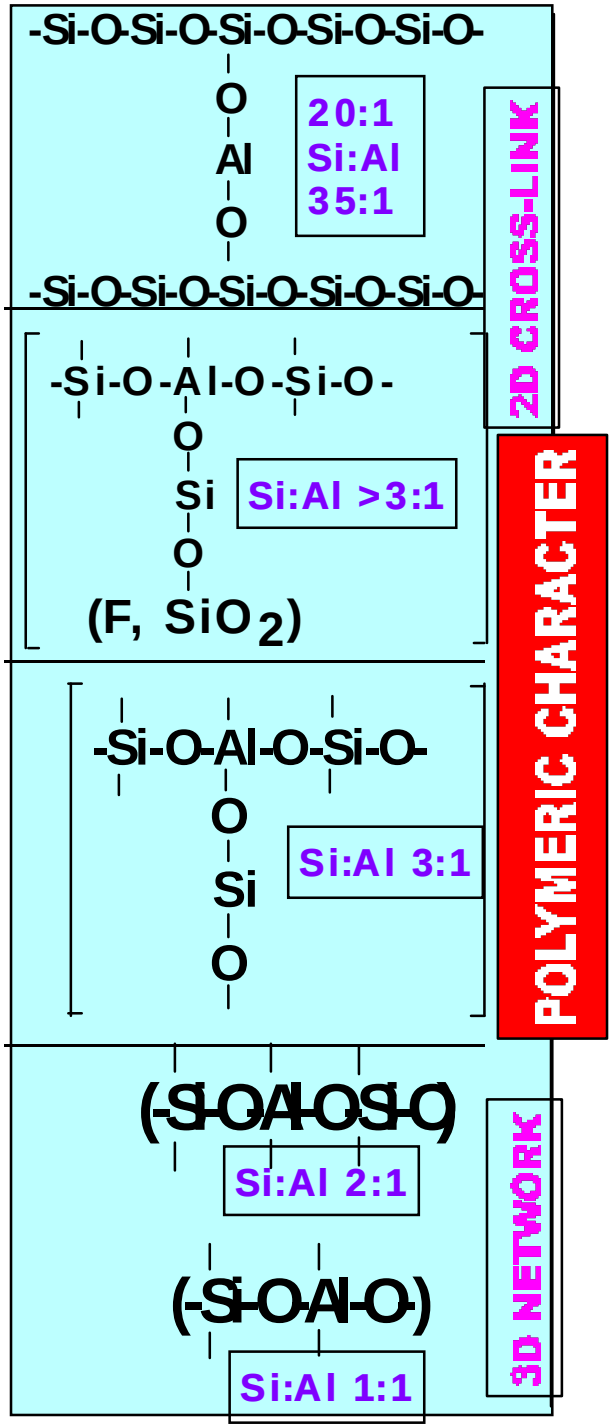
Giving Survivors more time to escape



1994-1995 F1 World Champion

Successful Niche Markets, small companies,

patent rights sold to PYROMERAL SA.



Fire Resistant / Heat Resistant Carbon-fiber Composites

Tooling For AERONAUTICS SPF ALUMINUM / TITANIUM

Sealants FOR INDUSTRY 200- 1000 deg C

ALUMINUM FOUNDRY EQUIPMENTS

Foam for Heat insulation

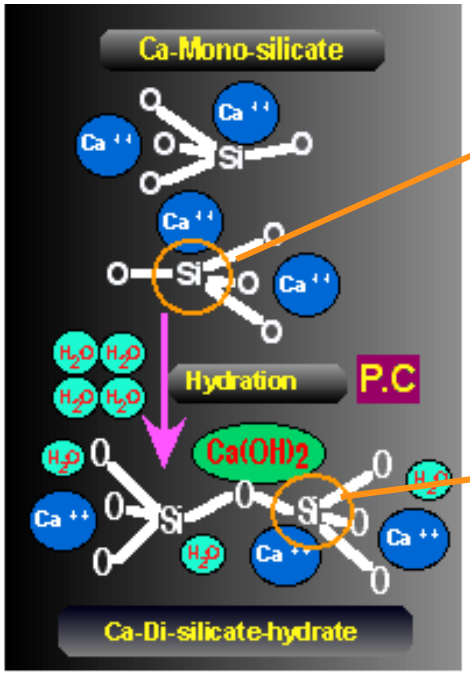
Radioactive &Toxic Waste ENCAPSULATION

Low CO_2 CEMENTS

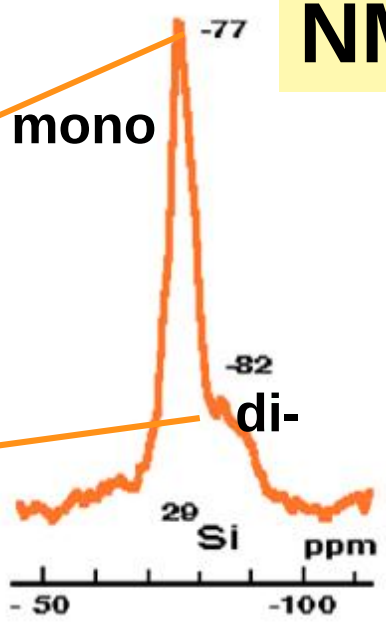
Chemical
and
molecular structure !

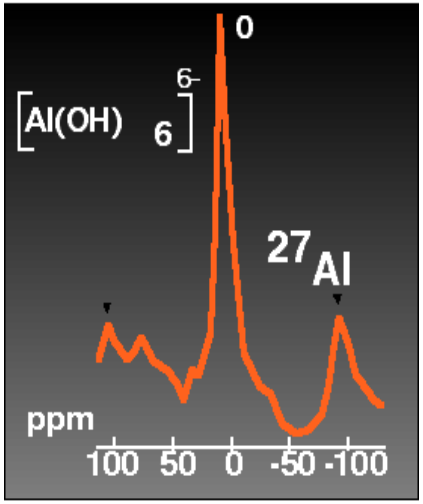
1987

Portland Cement

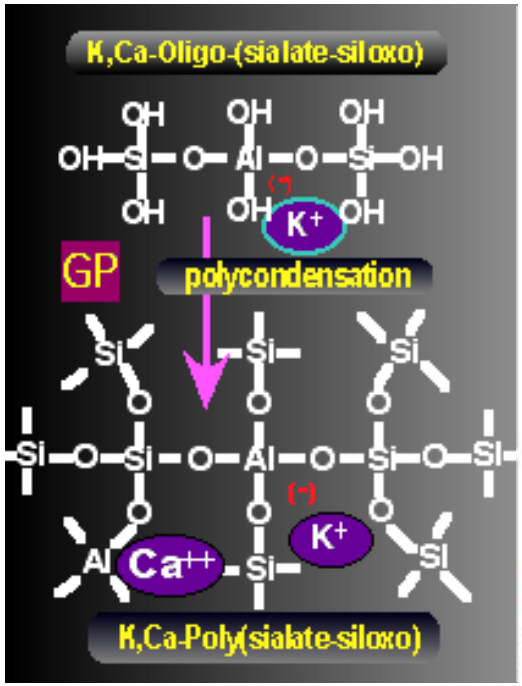


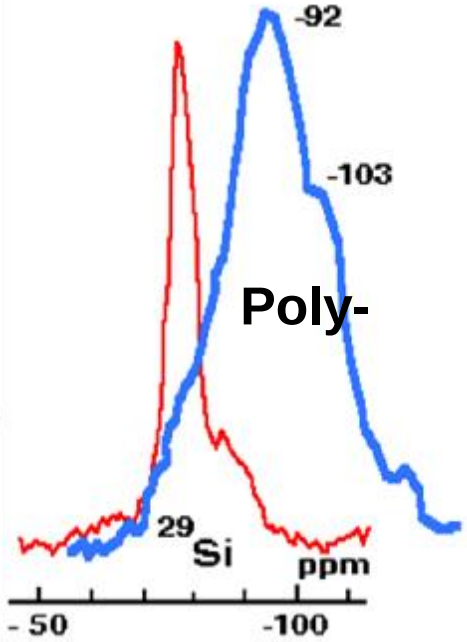
NMR

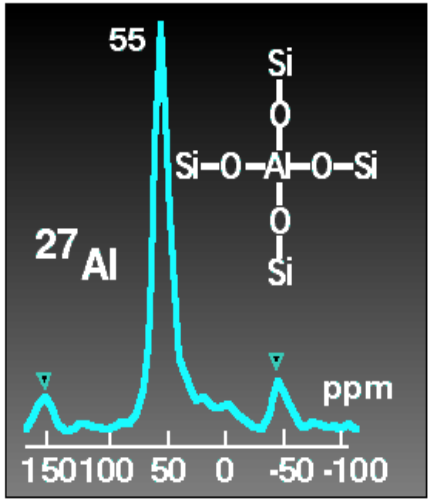




Geopolymer

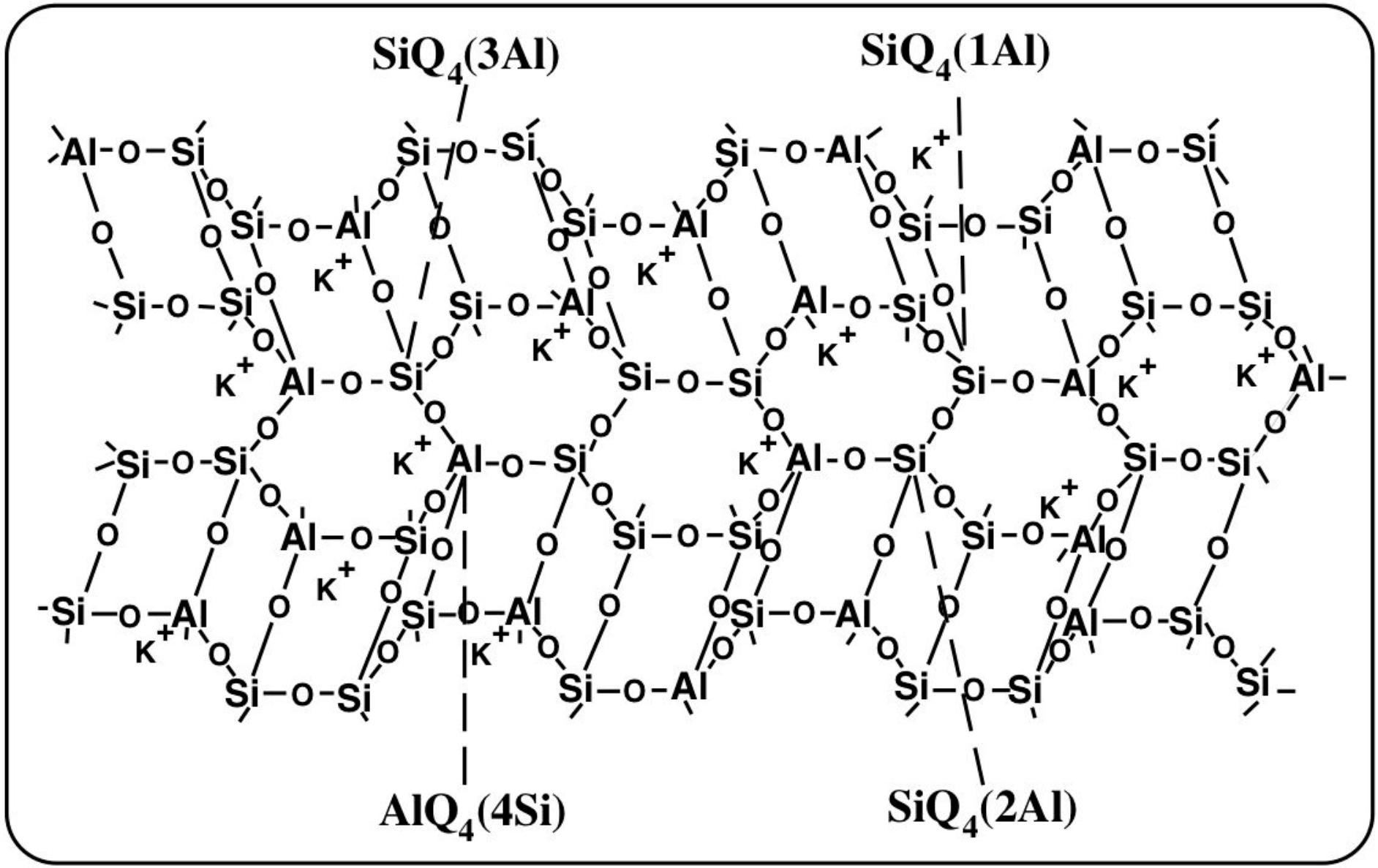


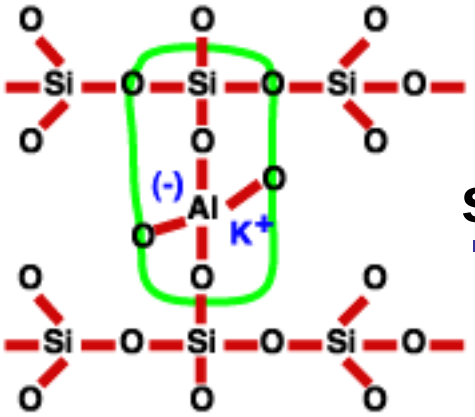




(Na,K)-(Si-O-Al-O-Si-O-)

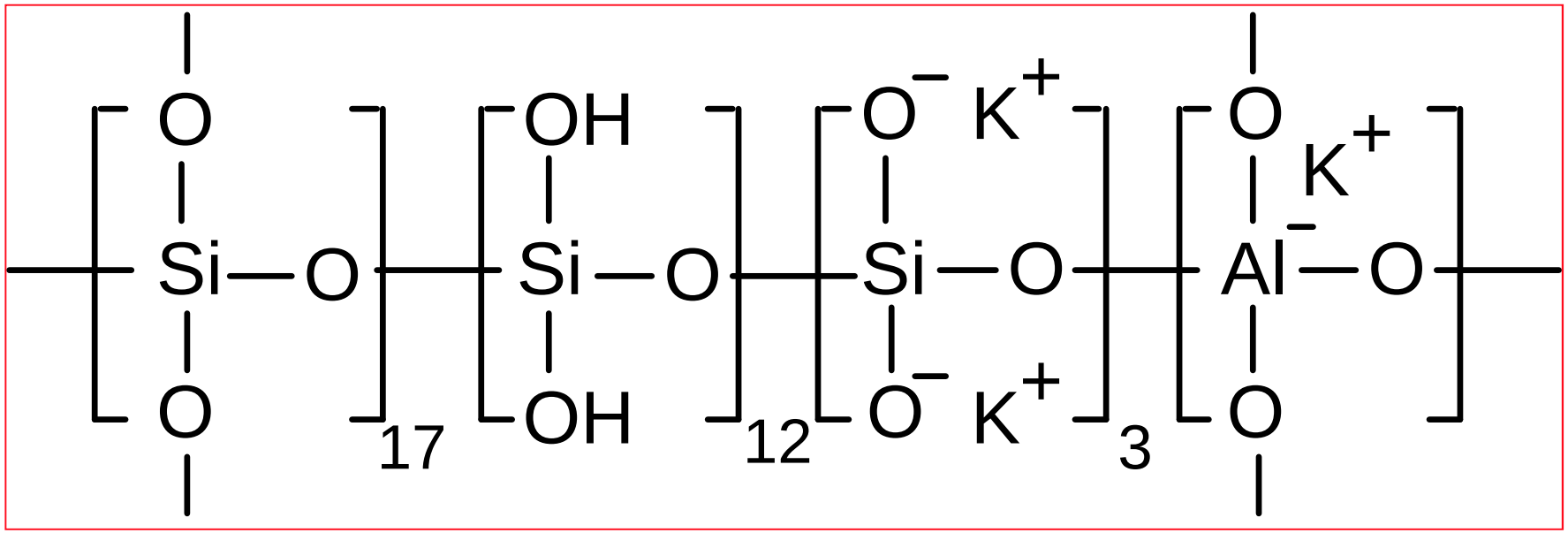
(Na,K)-poly(sialate-siloxo) (Na,K)-PSS



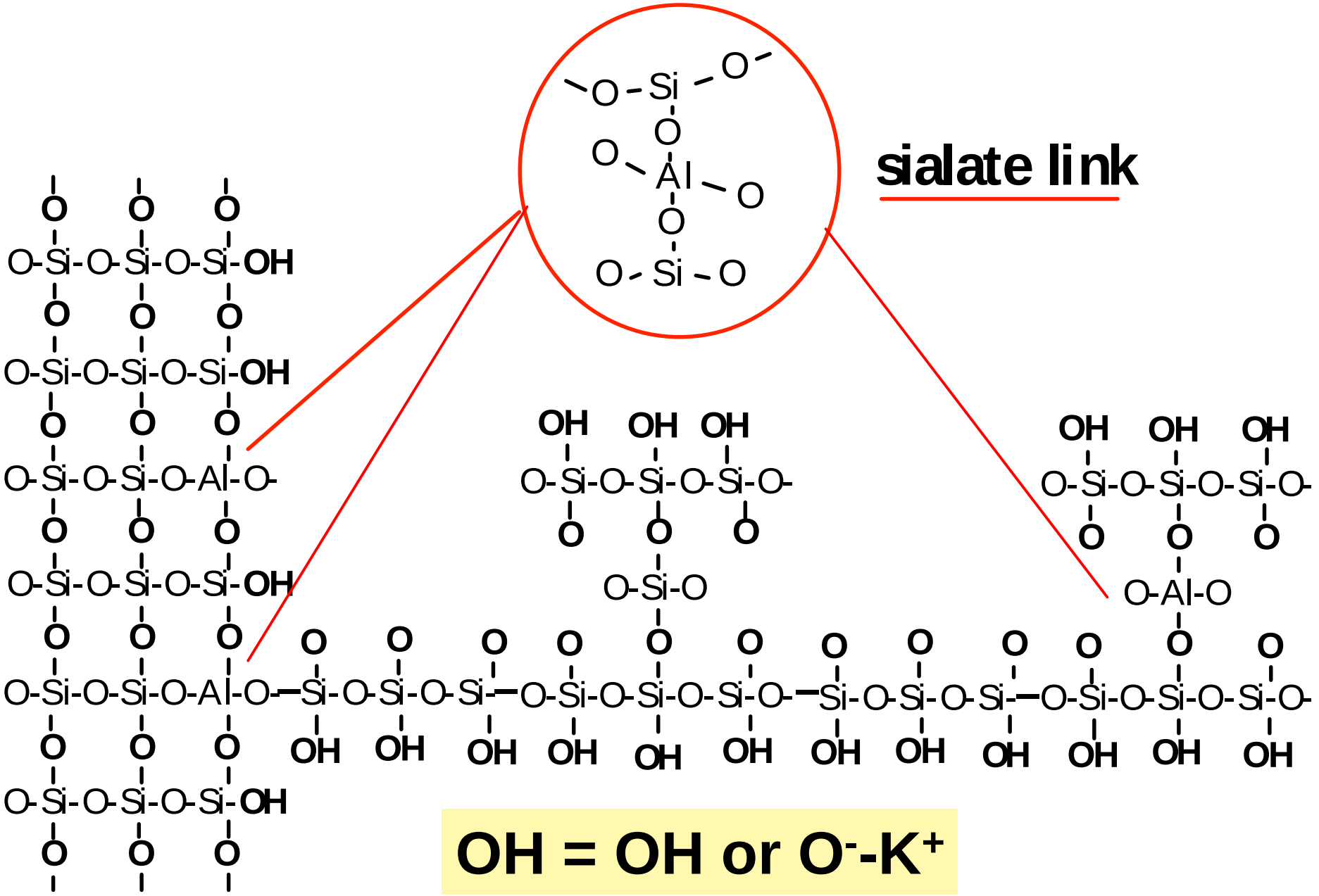


sialate link

Si:Al = 32:1



K-nano-poly(sialate)


sialate link
OH = OH or O-K+

Geopolymer
high molecular, macromolecules

not gel,
or unknown structure
or colloids,

Geopolymer
high molecular, macromolecules

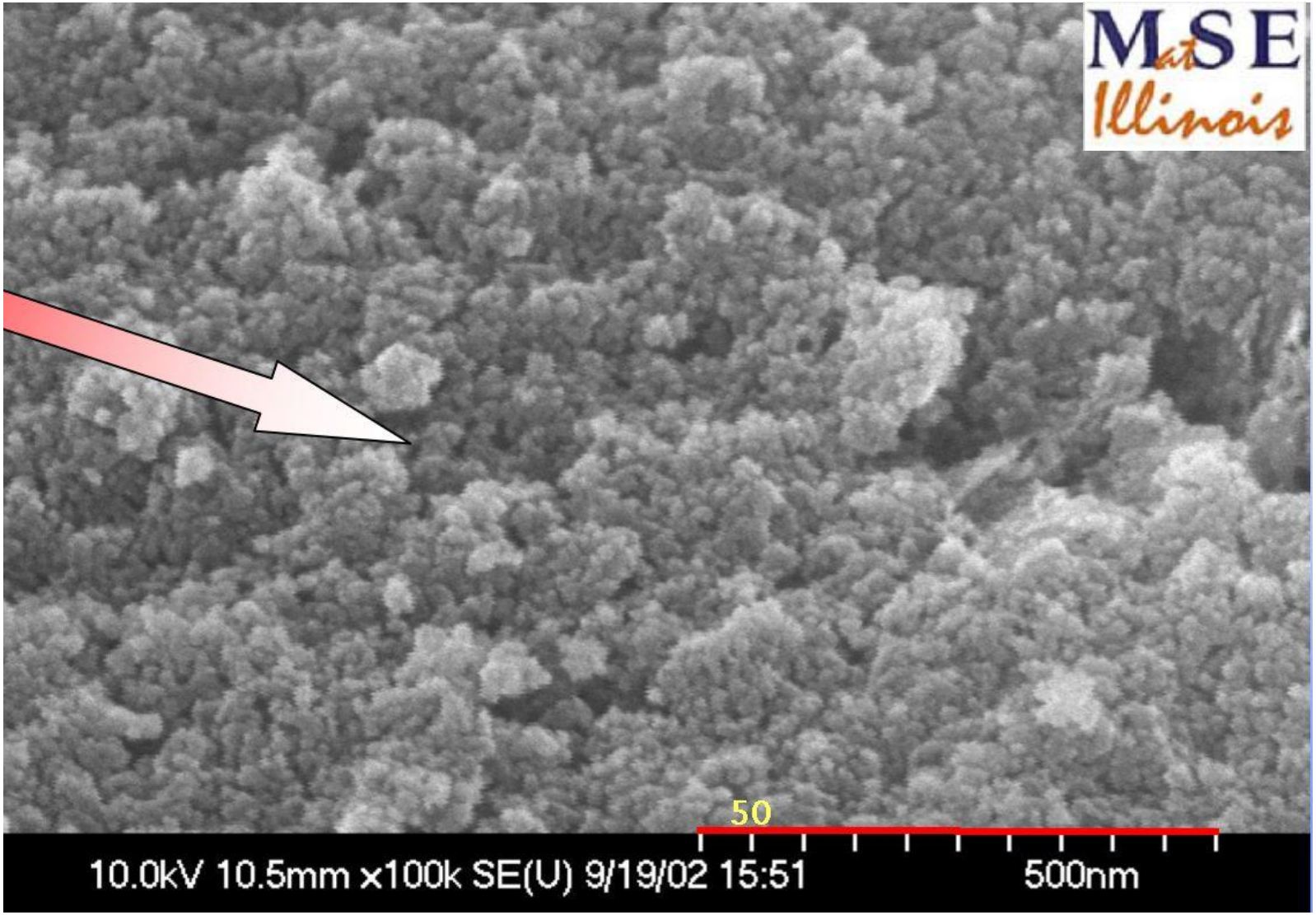
determination of molecular weight

poly(sialate) (Si-O-Al-O-)n

512 < n < 8000

60,000 < MW < 850,000

5 nm (50A) < d < 15 nm (150 A)



Individual geopolymeric micelle (particulate)

10 nm (100 A)

Until 1999

2nd Geopolymer Conference,

GP' 99, Saint-Quentin

geopolymers = advanced knowledge

in alumino-silicate chemistry

Since 2002

3rd Geopolymer Conference

GP' 2002, Melbourne

everything that is not Portland cement is called Geopolymer.

alka ste

Ge !!

4th Geopolymer Conference, GP' 2005

Saint-Quentin,

separate session

alkali-activated materials.

My decision

No more participation

to alkali-activation conferences.

Why ?

Alkali-activation

wrong terminology

“The potential for alkali-reactive geological materials in Belgium”

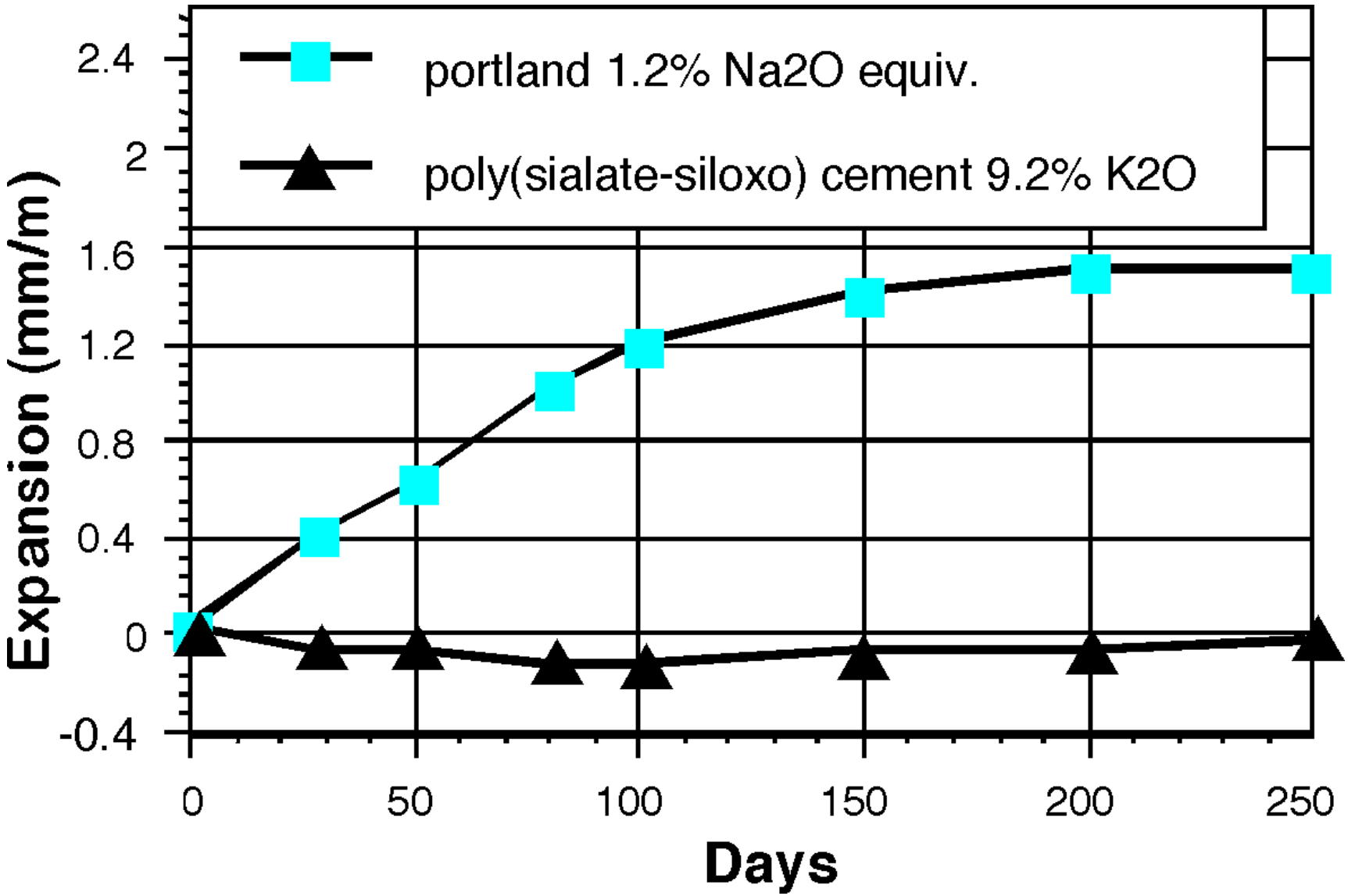
AAR

alkali-aggregate reaction

ASR

alkali-silica-reaction

A.A.R. on Portland and Geopolymer



For civil engineers

alkali = danger

ABC

alkali-bounded-ceramic

AAC

alkali-activated-cement

AAS

alkali-activated slag

AAFA

alkali-activated-fly ash

AAIP

alkali-activated inorganic polymer

Alkali-activation

first step of geopolymerization

1) alkali-activation (alkalination)

2) Dissolution of $Si(OH)_4$, $Al(OH)_4$

3) Gel formation of oligo-sialates

4) Polycondensation

5) Reticulation, networking

6) Geopolymer solidification

Alkalination,

a well known process

going back to Antiquity

QUIZ GAME

AAPF

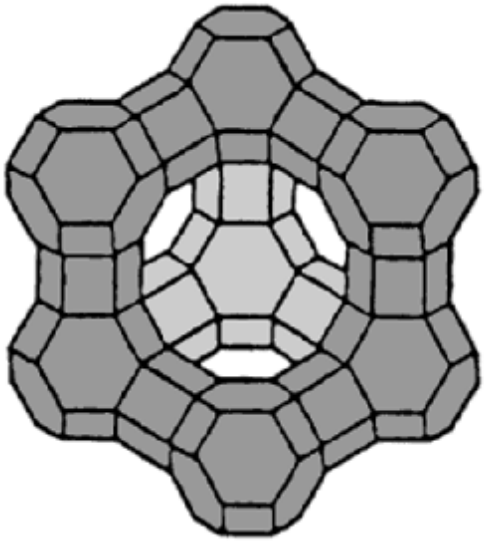
alkali-activated phenol / formaldehyde

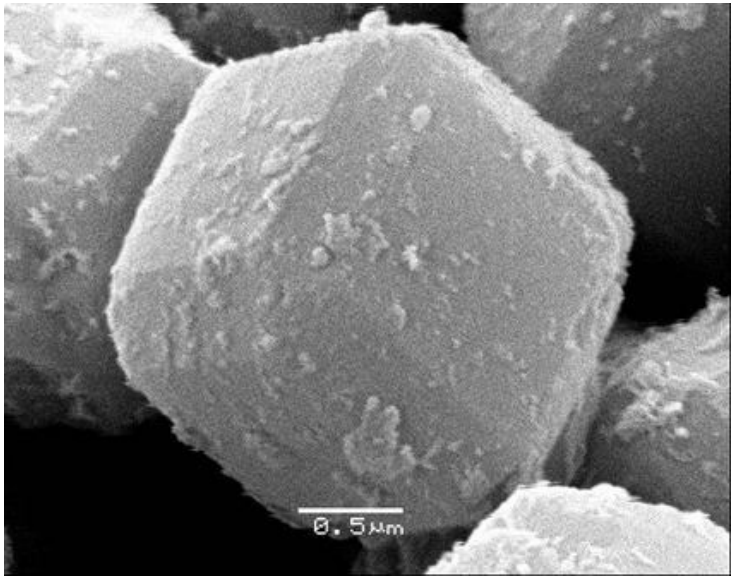
BAKELITE, polycondensation, phenoplast

300 kg NaOH / 1 t. of plastic.

AAS

alkali-activated silicate





synthetic ZEOLITE

AAC

alkali-activated cellulose

VISCOSE - RAYON artificial fibers

500 kg NaOH / 1 t. fiber.

AAB

alkali-activated bauxite

ALUMINUM production

200 kg NaOH / 1 t. aluminum.

AAG

alkali-activated glycerin / oil

SOAP, saponification,

250 kg NaOH / 1 t. soap.

Terminology

Ionic or covalent bonding ?

1968 : A. Noll (Germany)

1982 : G.V. Gibbs (USA)

2000 : G.V. Gibbs (USA)

2000 : M.R. North & T.W. Swaddle (USA)

2004 : M.R. Rowles (Australia)

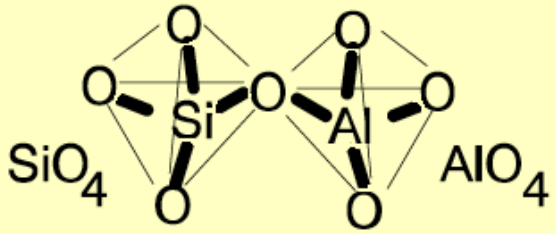
Covalent, macromolecules, polymeric terminology

Silicones and geopolymers

1979 Geopolymer Terminology

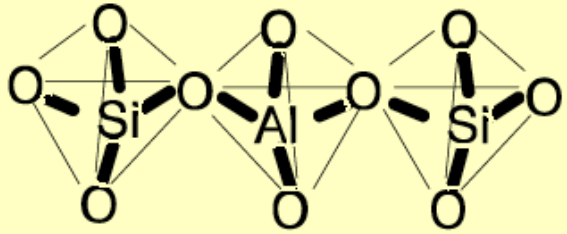
Si:Al = 1:1

Poly(sialate)
(-Si-O-Al-O-)



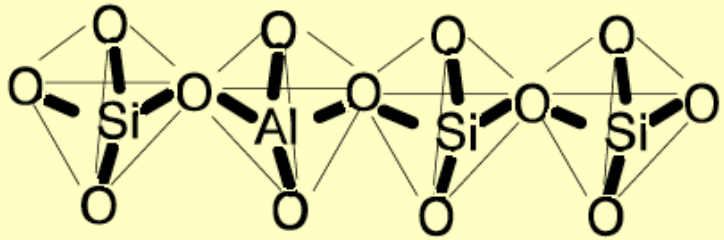
Si:Al = 2:1

Poly(sialate-siloxo)
(-Si-O-Al-O-Si-O-)

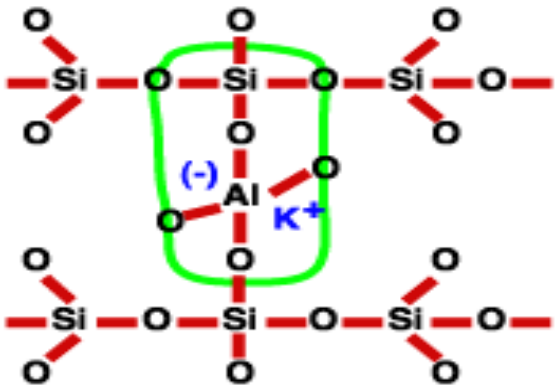


Si:Al = 3:1

Poly(sialate-disiloxo)
(-Si-O-Al-O-Si-O-Si-O-)



Si:Al >3:1 **Sialate link**



What is a geopolymer ?

Chains or networks of mineral molecules linked with co-valent bonds

-Si-O-Si-O- siloxo

-Si-O-Al-O- sialate

-P-O-P-O- phosphate

-P-O-Si-O-P-O- phospho-siloxo

-P-O-Si-O-Al-O-P-O- phospho-sialate

Geopolymers

presently 4 main classes

poly(siloxo) + derivates

poly(sialate) + derivates

polyphosphates + derivates

organo-mineral geopolymers

Geopolymer Institute

Promoting the geopolymer science since 1979

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www.geopolymer.org

Think geopolymer :
Burn, organic resin, burn !

A carbon-epoxy composite (left) is burning while a Carbon-Géopolymère Composite™ still resists a 1200°C fire

The Geopolymer Science
This introductory chapter presents the basic scientific knowledge dealing with the geopolymer chemistry.

Applied Technologies
With this comprehensive chapter, you will learn where geopolymers have been used and which are the potential applications.

Science Applied to Archaeology
The Geopolymer Institute is also involved in archaeology thanks to

News
Latest news in geopolymer science, commercial applications, R&D, funded projects, conferences, scientific papers, publications, PhD thesis, etc.

The Geopolymer Library
List of papers that are freely loadable as well as their abstracts. This selection of scientific and archaeological papers are considered as a "must read" for people who want to learn precise information on geopolymers.

Notes:

Version française

Buy the **GEOPOLYMER 2005 Proceedings** . A book + a CD-Rom containing 133 papers - 1190 pages, including GP'88, GP'99 and GP 2005.

Categories:

- News
- Science
- Applications
- Archaeology
- Library
- FAQ

Latest news:

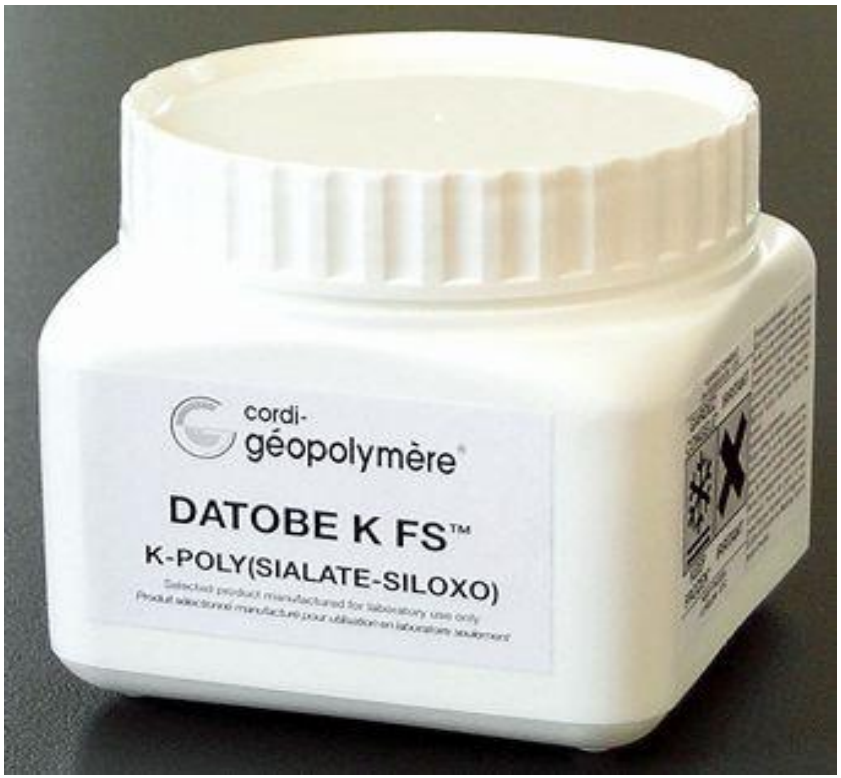
cordi-
géopolymère

www.geopolymere.com

Si:Al = 2:1 PSS

(Na,K)-(Si-O-Al-O-Si-O-) (Na,K)-poly(sialate-siloxo)

pre-mixed resin, frozen storage

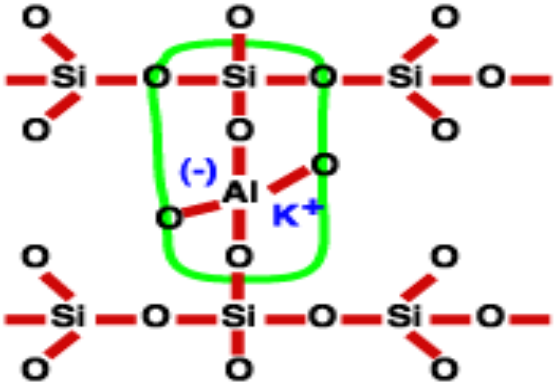


Si:Al = 2:1 PSS

(K,Ca)-(Si-O-Al-O-Si-O-) (K,Ca)-poly(sialate-siloxo)

two-components room temp. geopolymer cements
Rc up to 140-150 MPa

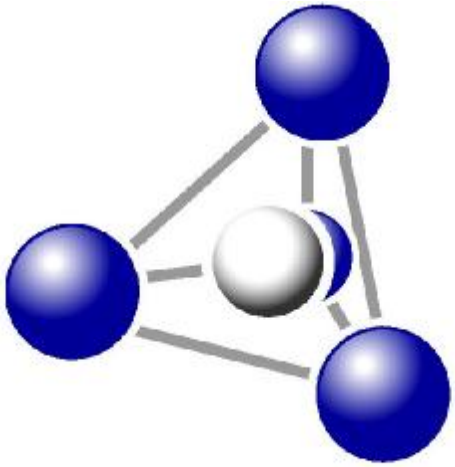
Si:Al >>3:1 Sialate link



K-Nano-Poly(sialate), Si:Al 20-32

pre-mixed frozen resin + hardener

www.cordi.geopolymere.com



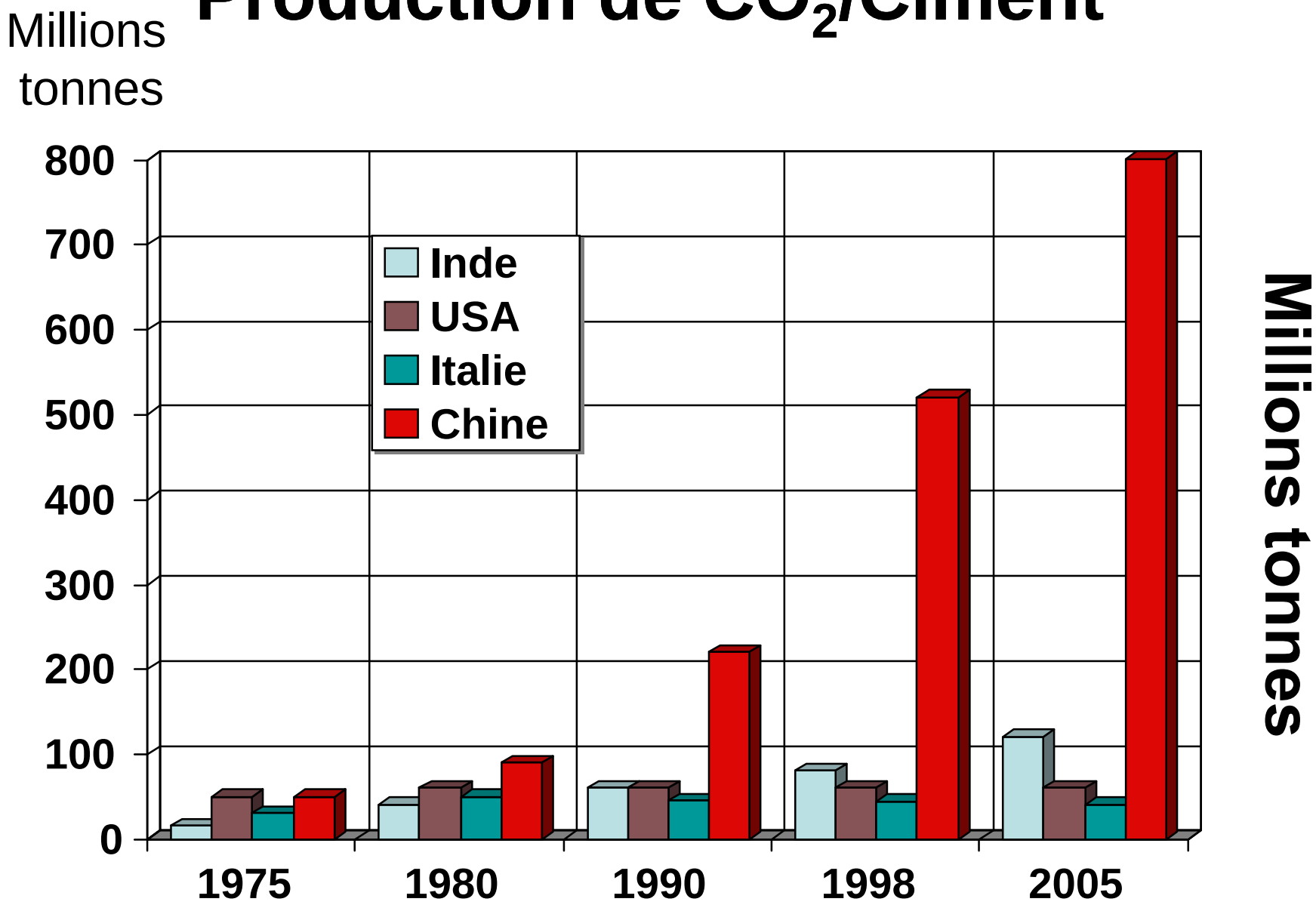
GEOPOLYMER

Advanced materials for the 21st century

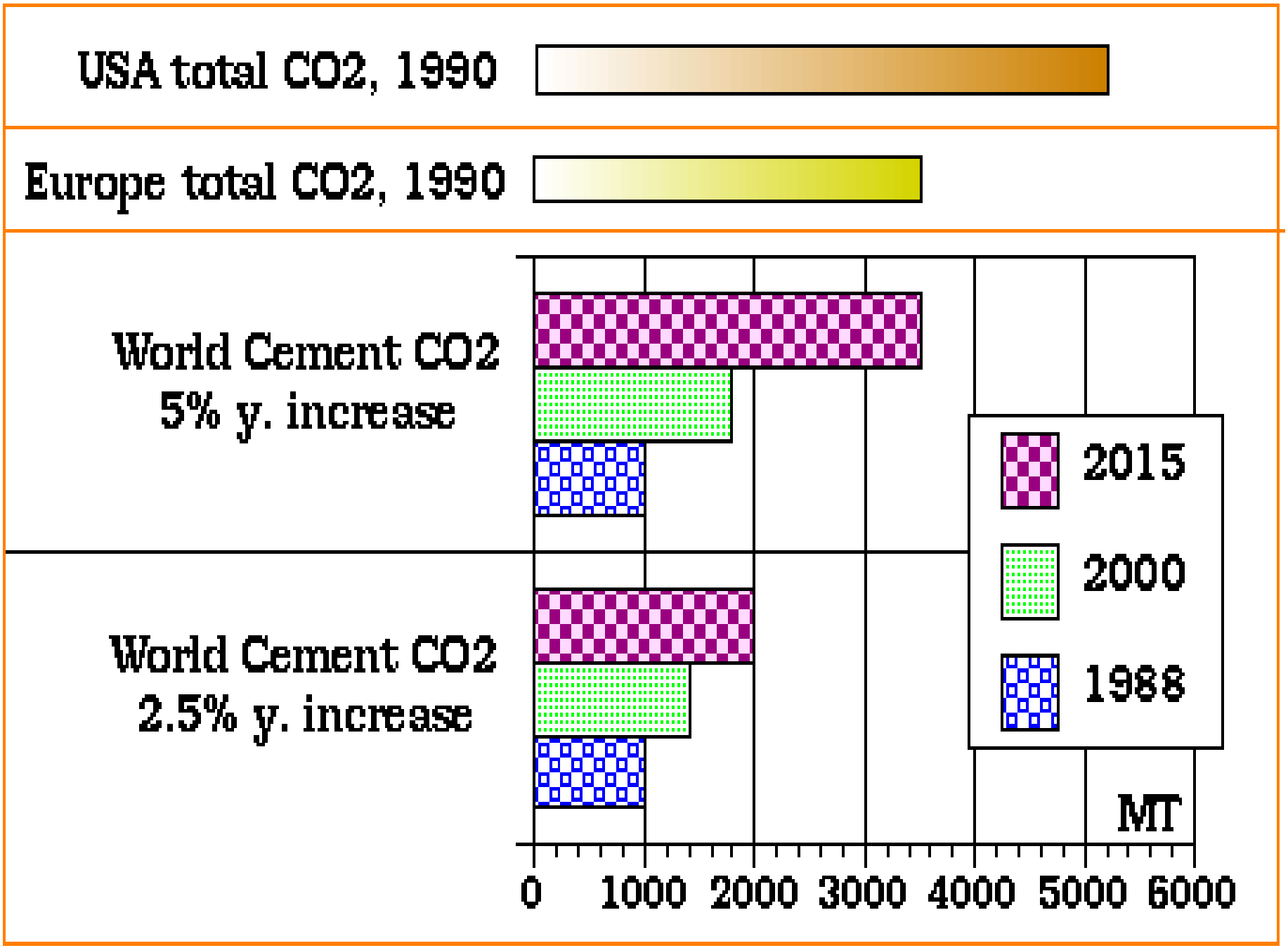
Polymeric terminology

is the key to success

Production de CO_2/Ciment



in 2015


USA total CO2, 1990
Europe total CO2, 1990
World Cement CO2
5% y. increase
World Cement CO2
2.5% y. increase
2015
2000
1988
MT
0
1000
2000
3000
4000
5000
6000

emission 1 t. CO_2

1 t. Portland cement

8-10 t. geopolymer cement

(8-10 times more)