INSTITUT GÉOPOLYMÈRE

UNIVERSITÉ de Picardie Jules Verne

CAMPUS universitaire de Saint-Quentin

PÔLE TECHNOLOGIQUE

2016 GEOPOLYMERCAMP

Laboratoire des Technologies Innovantes

Saint-Quentin (France)

July 4-6, 2016

Joseph Davidovits

Geopolymer Institute

www.geopolymer.org

State of the Geopolymer R&D 2016

Previous States of the Geopolymer R&D at GP-Camps

2009: Mass Produced Geopolymer Cement

2010: State of the Geopolymer R&D 2010

2011: State of the Geopolymer R&D 2011

2012: State of the Geopolymer R&D 2012

2013: State of the Geopolymer R&D 2013

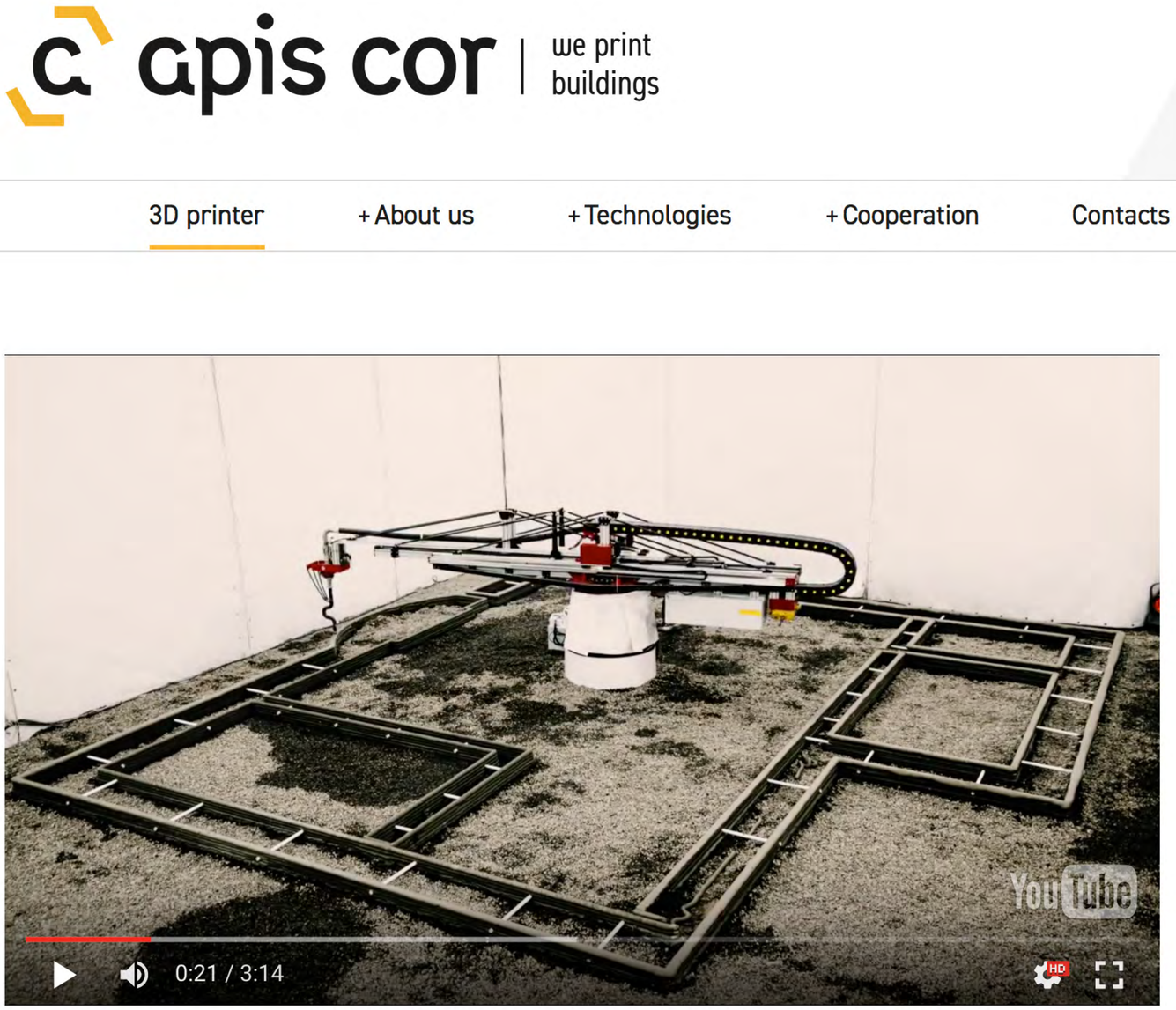
2014: State of the Geopolymer R&D 2014

2015: State of the Geopolymer R&D 2015

Dear prof. J. Davidovits,

I would like to know if it possible to make a presentation at 8th GP-Camp of our collaboration with a Russian company ***apis-cor***, who created a compact 3D printer for building houses.

Together with our Italian colleagues (with whom we got acquainted thanks to your 7th GP-Camp), we developed a geopolymer recipe specially for the needs of the company apis-cor and their printers and would like to share our experience on this.



State of the Geopolymer R&D 2016

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

3 important topics

1) *Part 3 of my campaign* against holdup perpetuated on geopolymer by AAM alkali-activated-materials / RILEM: *Why Alkali-activated-materials are not Geopolymer ?*

What scientists are now writing about this issue !

2) *Introduction to 3D-printing* for geopolymer technologies.
3) *My visit to Geopolymer Concrete Airport* and *Geopolymer Concrete Building* in Australia.

State of the Geopolymer R&D 2016

1) Geopolymer science

Why AAM are not Geopolymers: part 3

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

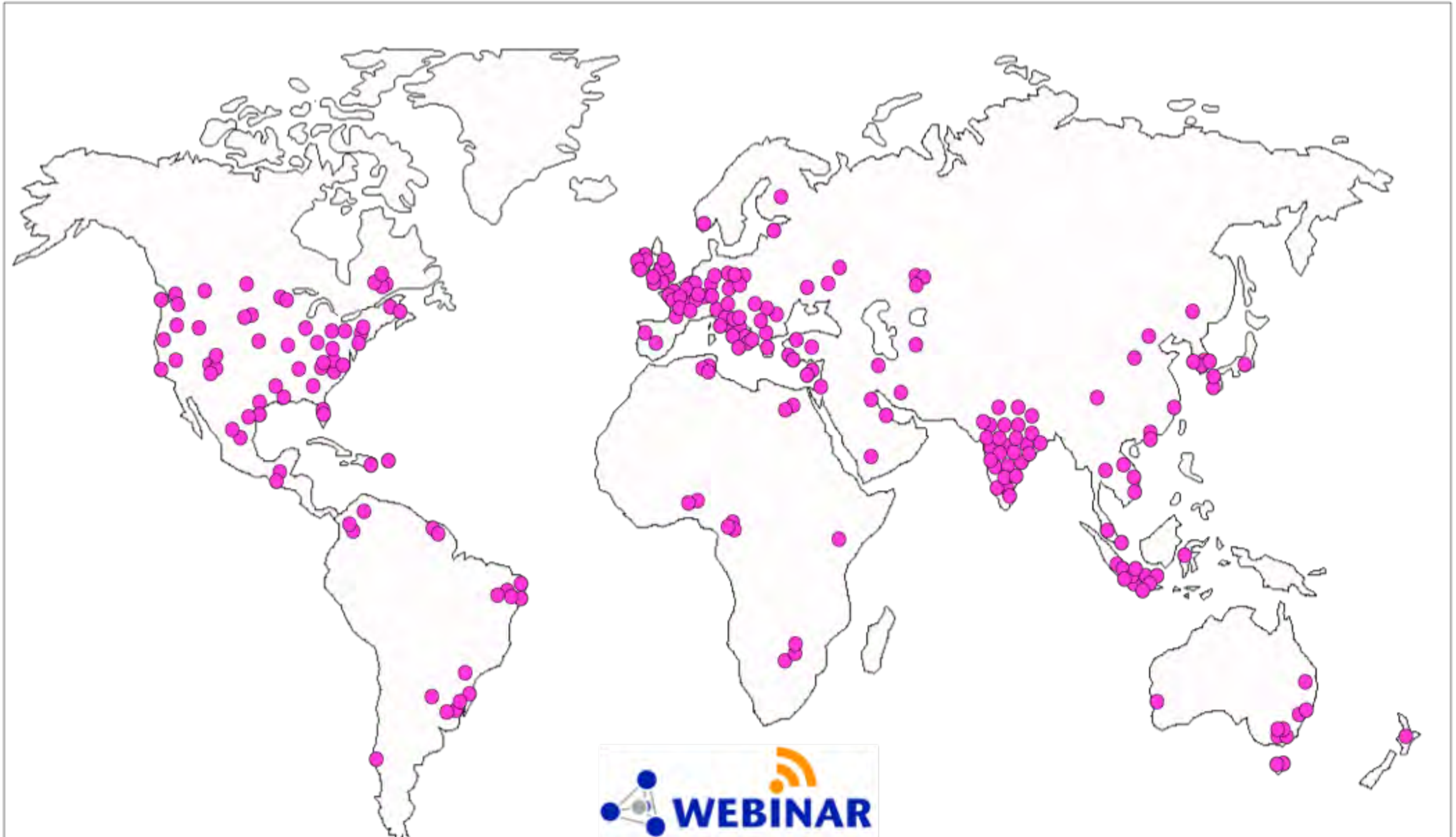
4) Geopolymer and archaeology

Spring 2016

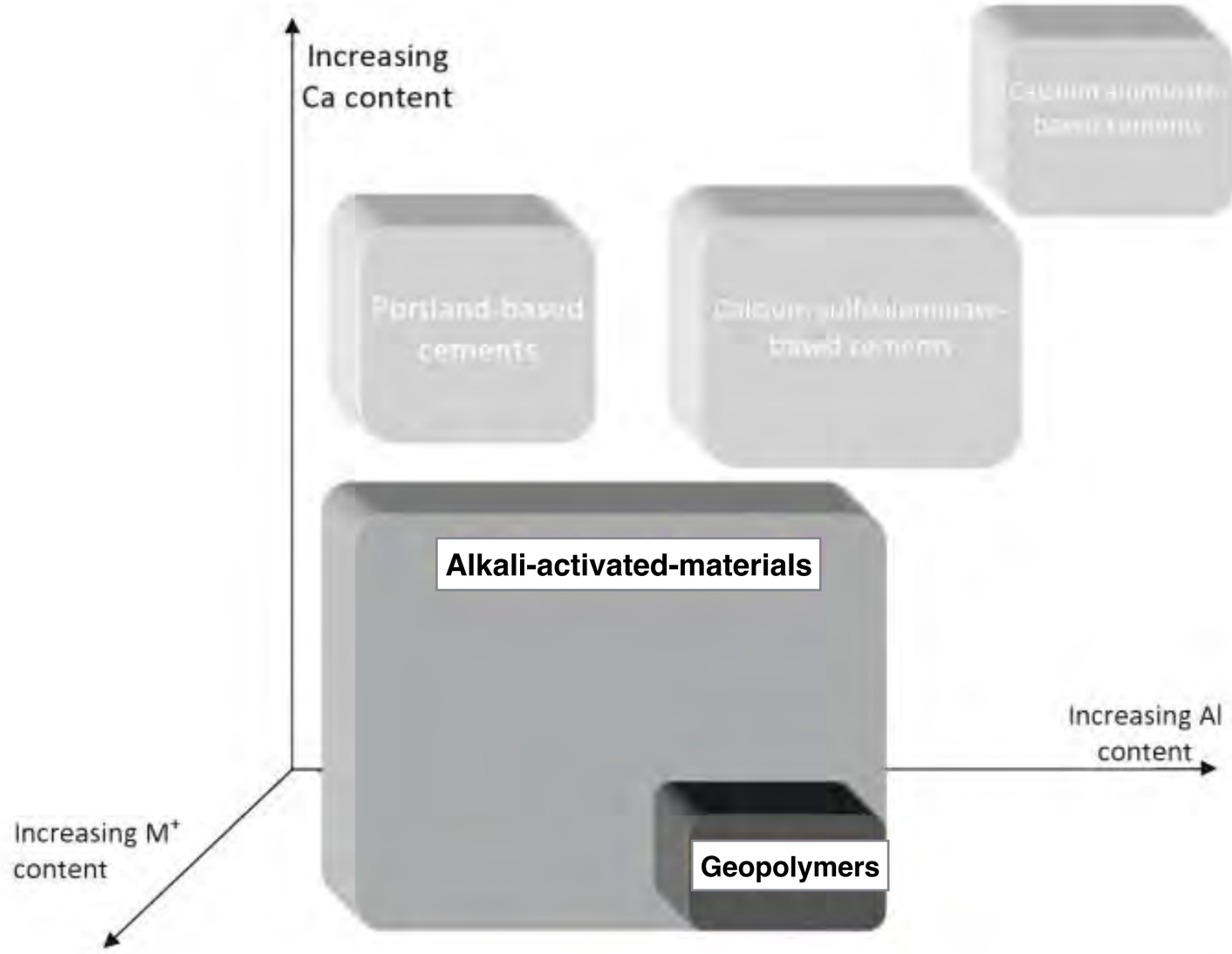
www.**geopolymer**.org

Geopolymer WEBINAR Spring 2016

250 Registered Participants

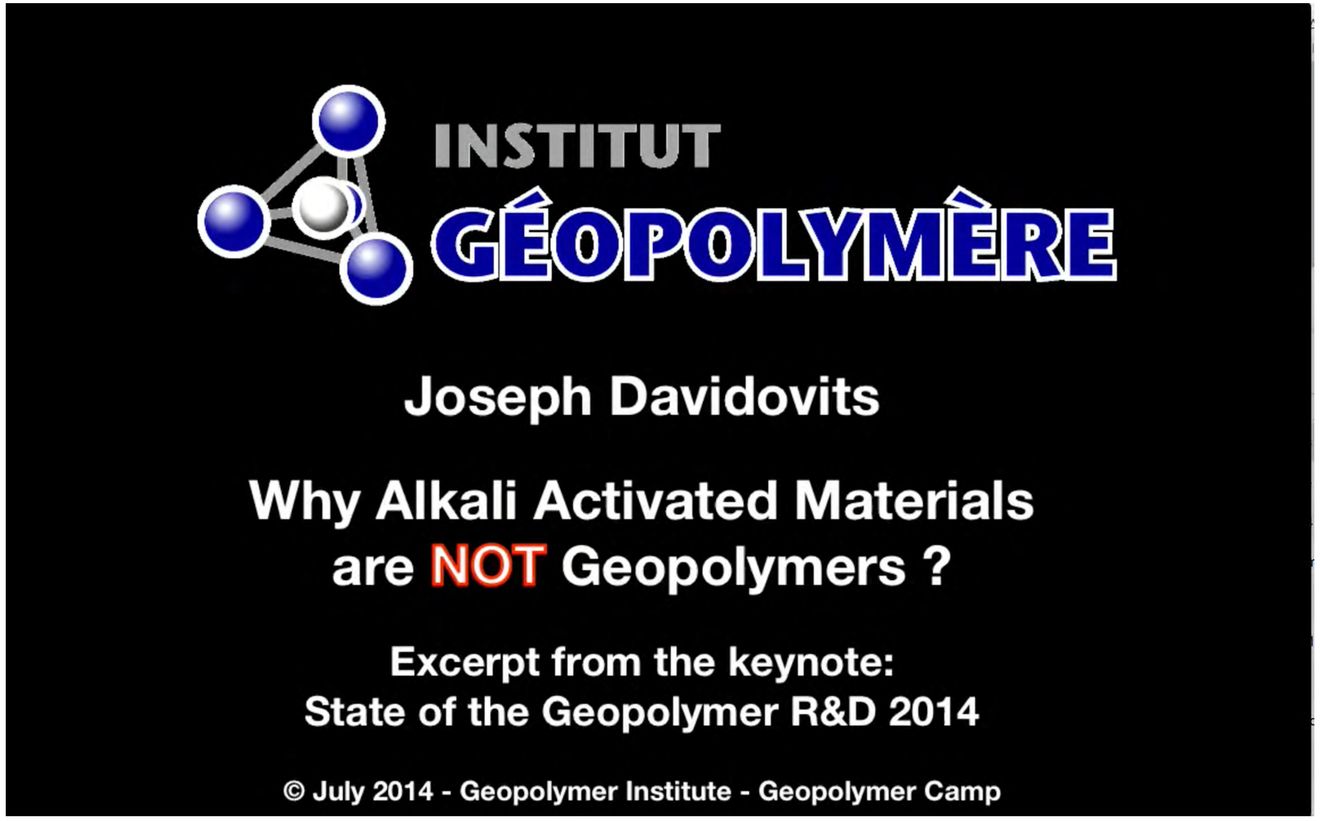


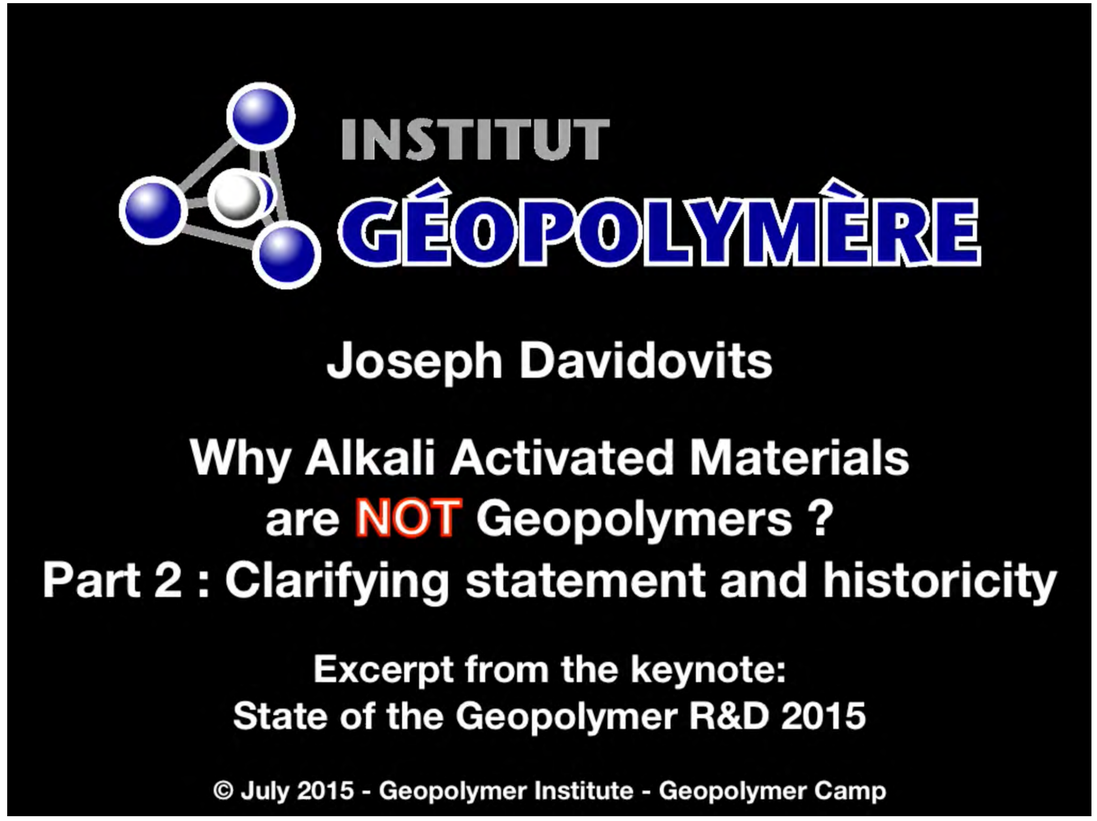
This video lasts 2h15, a 265 MB file. Click on the icon on the right to watch it fullscreen.



Classification of Alkali-Activated-Materials AAM according to J.L. Provis / RILEM and the small area devoted to Geopolymers

Why Alkali-Activated Materials (AAM) are not Geopolymers ?





Aug. 2014: GP-Inst. > 12,470
YouTube > 4,000

Aug. 2015: GP-Inst. > 4,215
YouTube > 1,020

Why Alkali-Activated Materials (AAM) are not Geopolymers ?

Part 3

What scientists are now writing about this issue !

Because

Alkali-activated Materials **are not POLYMERS**.

They **cannot be called GEO-POLYMERS**

2 very different systems!

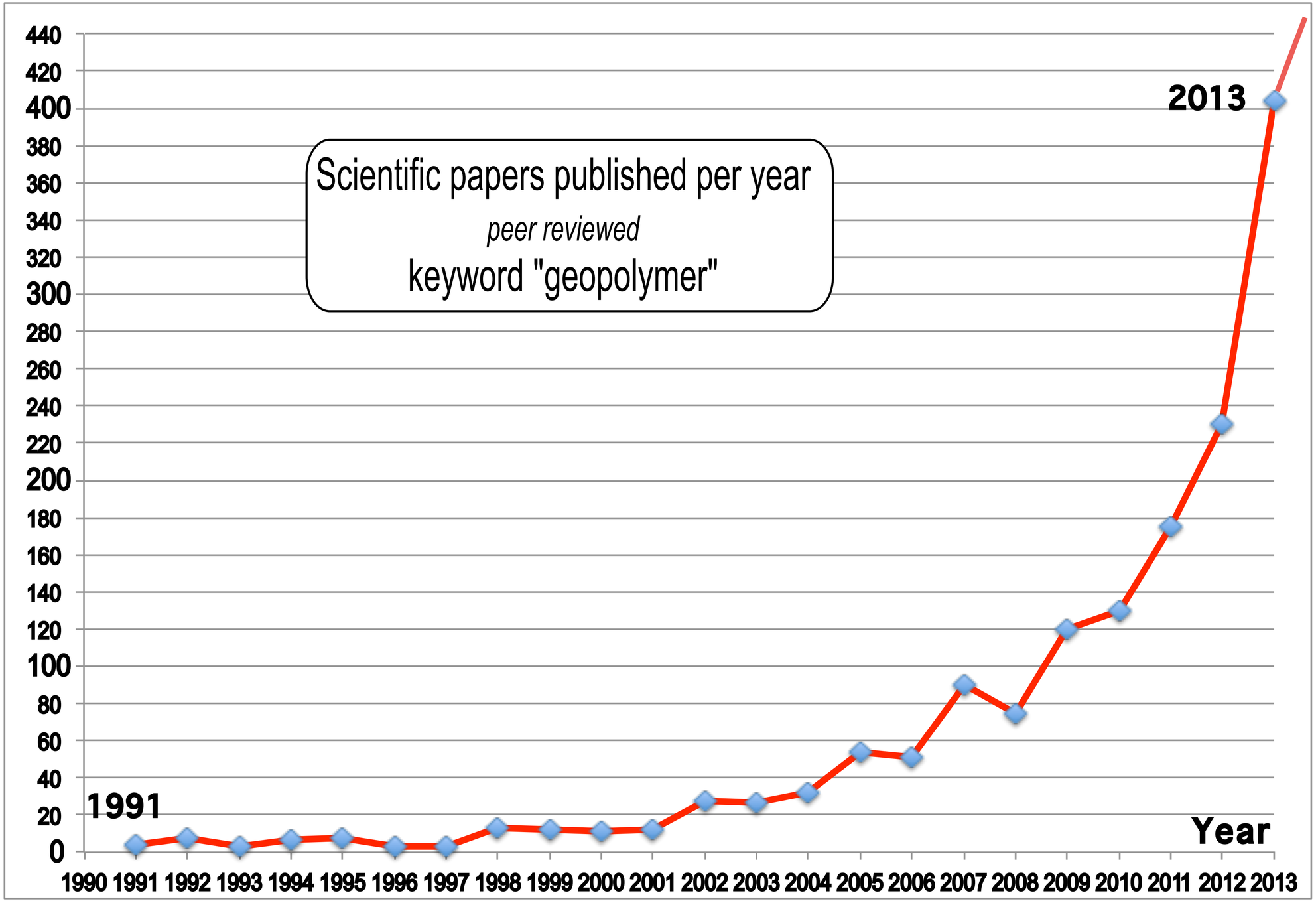
It is a big scientific mistake to use both as synonyms.

Alkali-activation is a wrong terminology for geopolymers.

Geopolymer research 1988

1st Geopolymer conference

Geopolymer research 2013


Scientific papers published per year
peer reviewed
keyword "geopolymer"
2013
1991
Year
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
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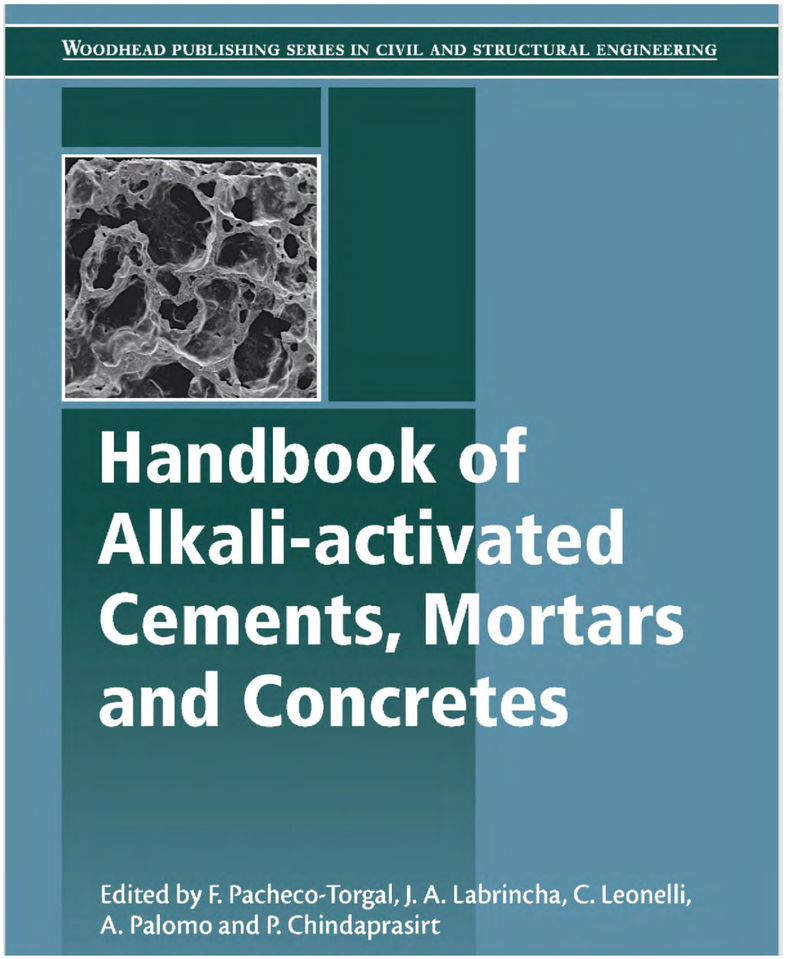
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013



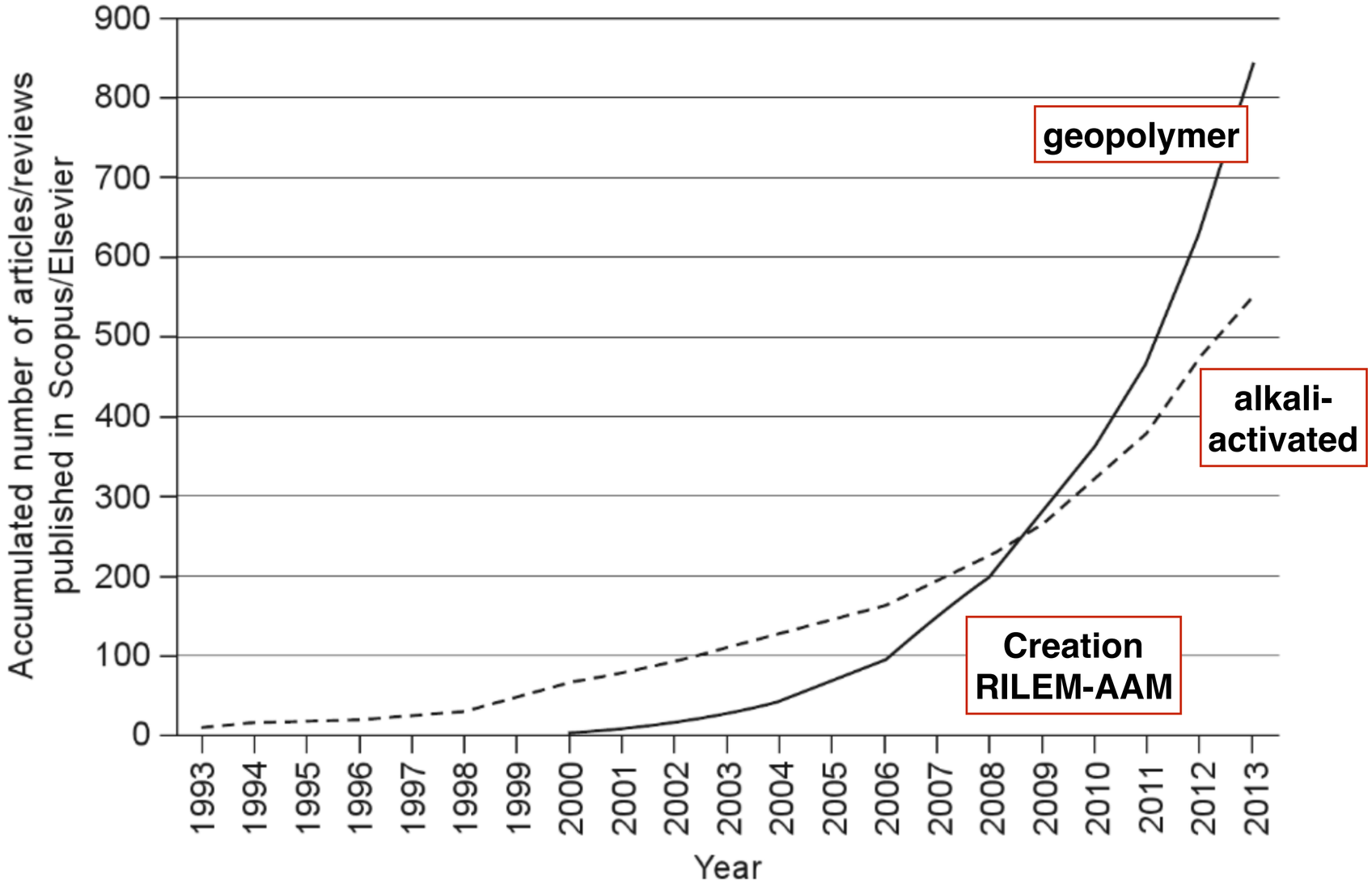


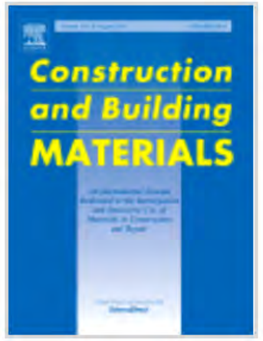
Figure 1.1 Evolution of the accumulated number of articles/reviews published in Scopus/Elsevier journals by the keyword 'alkali-activated' (dotted line); and the keyword 'geopolymer' (solid line) searched in the sections title, abstract or keywords.

Another interesting fact was that two Elsevier BV journals published the majority of AACB related papers. ***Construction and Building Materials*** has the highest number of 'geopolymer' papers while ***Cement and Concrete Research*** was the lead journal for alkali-activated papers.

ELSEVIER

Construction and Building Materials

Volume 122, 30 September 2016, Pages 36–42



ELSEVIER

Contents lists available at ScienceDirect

Cement and Concrete Research

journal homepage: http://ees.elsevier.com/CEMCON/default.asp

Also it was not until the twenty-first century that the first Technical Committee in the area of alkali activation was formed.

The RILEM Technical Committee on Alkali-activated Materials (TC 224-AAM) was initiated in 2007 and concluded its work in 2012 and the state-of-the-art report was published recently (J. L. Provis and J. van Deventer, 2013-2015).

Fortunately the participants had the good sense to ***embrace the alkali-activated terminology*** even though some had published the majority of their research on geopolymers (low calcium alkali-activated systems).

Alkali-Activated Materials

State-of-the-Art Report, RILEM TC 224-AAM

1. Introduction and Scope

John L. Provis[1,2]

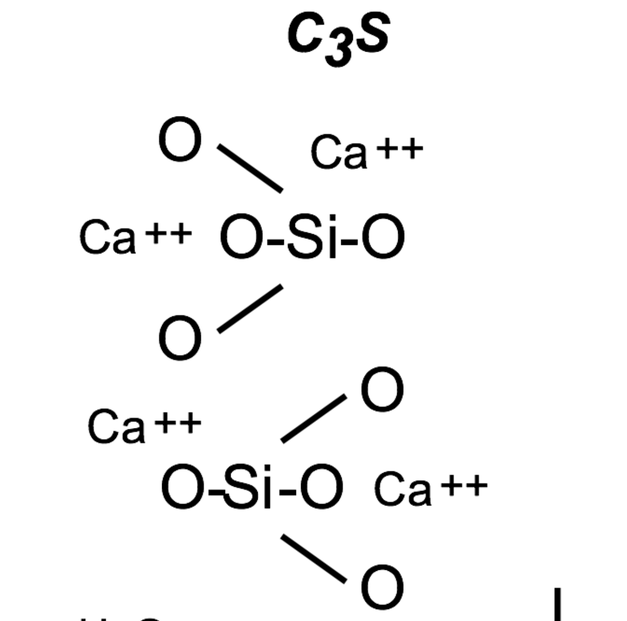
[1] Department of Materials Science and Engineering, University of Sheffield, Sheffield S1 3JD, UK*

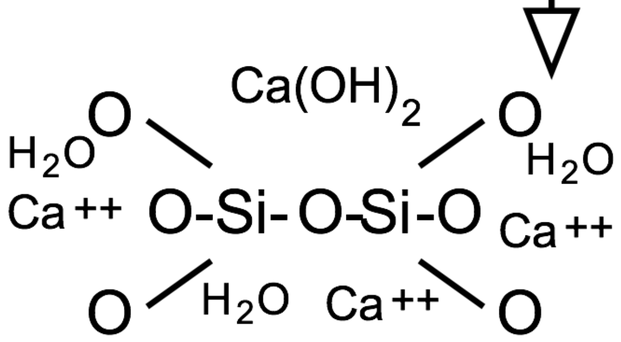
[2] Department of Chemical & Biomolecular Engineering, University of Melbourne, Victoria 3010, Australia

precursors used in geopolymer synthesis [22]. It is also noted that the term 'geopolymer' is also used by some workers, both academic and commercial, in a much broader sense than this; this is often done for marketing (rather than scientific) purposes.

See Part 2 of "*AAM are not Geopolymers*"

Portland Cement

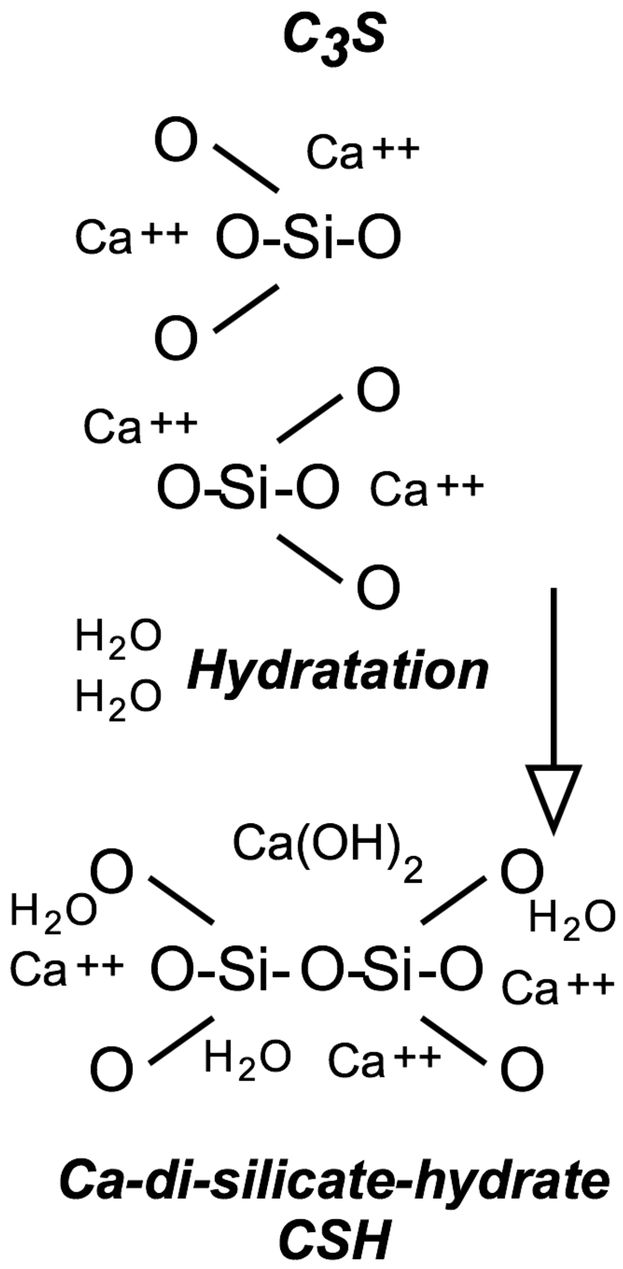


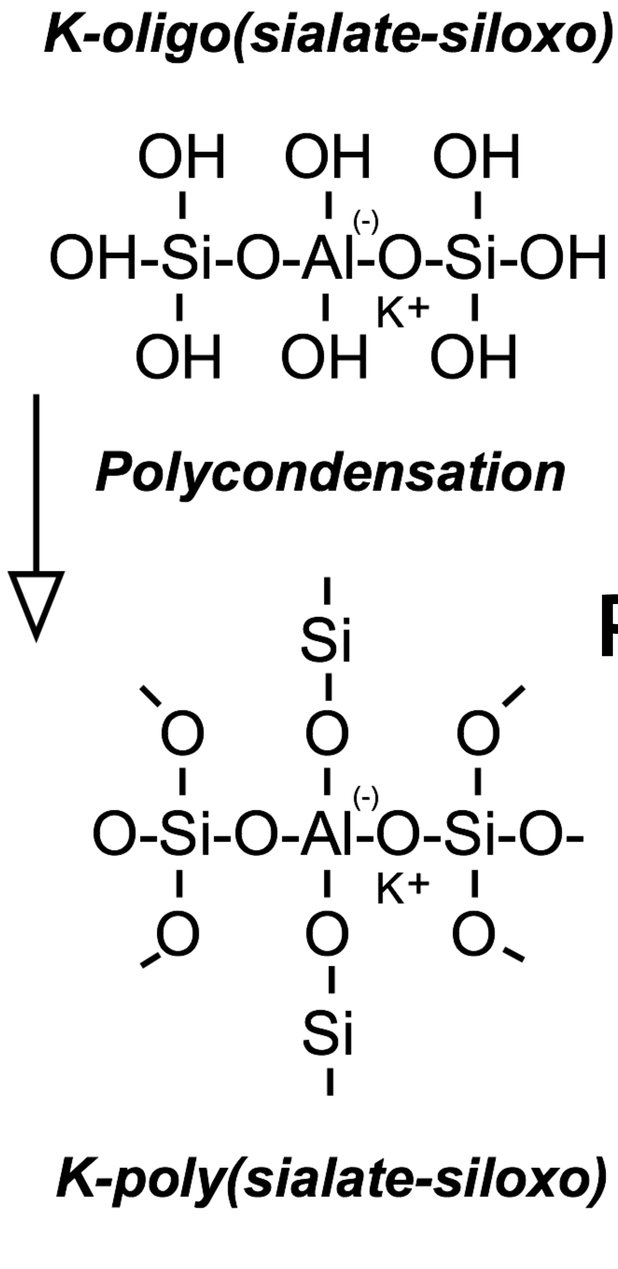


Ca-di-silicate-hydrate
CSH

a)

Portland Cement





Geopolymer is a **Polymer Chemistry** *(poly-sialate)*

Alkali-activated-materials scientists

substitution of Ca with Na, K

Portland cement

$CaO.SiO_2.H_2O$ Calcium Silicate Hydrate

C-S-H

Geopolymer

$Na_2O.2SiO_2.Al_2O_3.H_2O$ Sodium-Silico-aluminate-Hydrate

N-A-S-H

$K_2O.2SiO_2.Al_2O_3.H_2O$ Potassium-Silico-aluminate-Hydrate

K-A-S-H

According to RILEM

"GEOPOLYMER" is a type of

alkali-alumina-HYDRATE, a precipitate,

N-A-S-H, K-A-S-H

Nothing else !!!

WRONG

What scientists are now writing about this issue !

International Conference on Durability of Concrete Structures

GDDCE
SZDCE

广东省滨海土木工程耐久性重点实验室
Guangdong Provincial Key Laboratory of Durability for Marine Civil Engineering

深圳市土木工程耐久性重点实验室
Shenzhen Durability Center for Civil Engineering

Time: Jun 30 –Jul 1, 2016
Location: Shenzhen, P.R.China

5th International Conference on Durability of Concrete Structures
Jun 30–Jul 1, 2016
Shenzhen University, Shenzhen, Guangdong Province, P.R.China

2016

Study on the Disposition of Water in Fly Ash-Based Geopolymers Using ATR–IR

Jian Liu and Yuan Fang
School of Civil Engineering, Shenzhen University, China

Obada Kayali
School of Engineering and Information Technology, University of New South Wales, Canberra, Australia

ABSTRACT

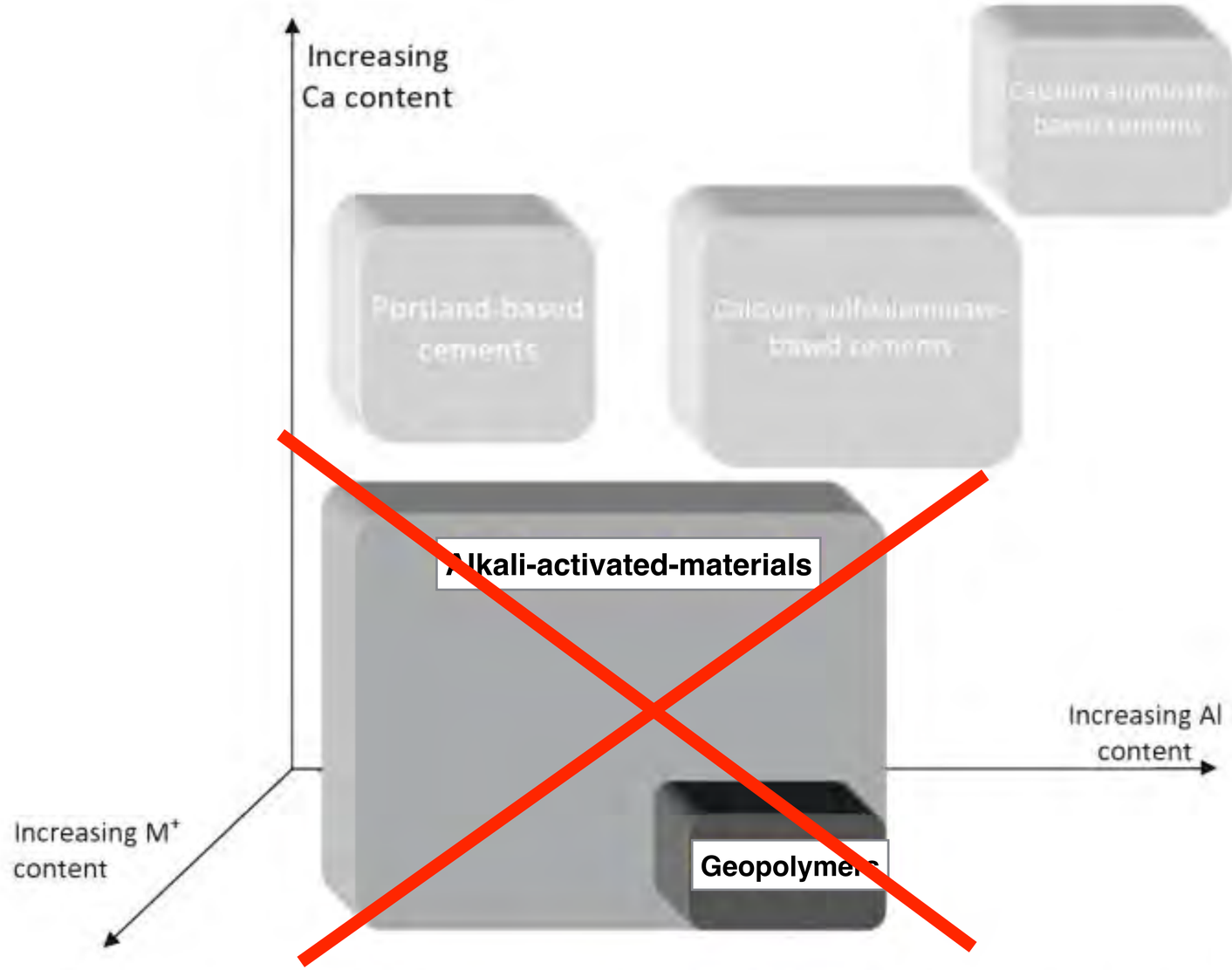
This paper addresses the question of whether the main product of low calcium fly ash-based **geopolymer is a hydrate, namely, sodium aluminosilicate hydrate (N-A-S-H)**. The answer to this question is important for understanding geopolymer characteristics……

" Contrary to Davidovits' perception about **geopolymer not being a hydrate**, some researchers since 2005 (Fernández-Jiménez, Palomo, etc…), have claimed that Na-geopolymer is sodium aluminosilicate hydrate (N-A-S-H)…[*i.e. alkali-activated-material*] ….together with K-A-S-H (potassium aluminosilicate hydrate) or similar gels……

The concepts "N-A-S-H", "K-A-S-H" were widely accepted in the description of geopolymers (J.L. Provis, J. van Deventer, 2011)… [*adopted by the RILEM-AAM Committee*]

Davidovits (2012), however, has clearly pointed out that a geopolymer is not a hydrate and the term N-A-S-H is not correct to define a Na-geopolymer. Moreover, he called for an effort to be made to stop giving "bad" definition to geopolymers with non-proven facts.

Conclusion: The evidence obtained from IR is not adequate to prove the existence of structural water, and **assumption** that the main product of **Na-geopolymer is N-A-S-H is not favoured."**



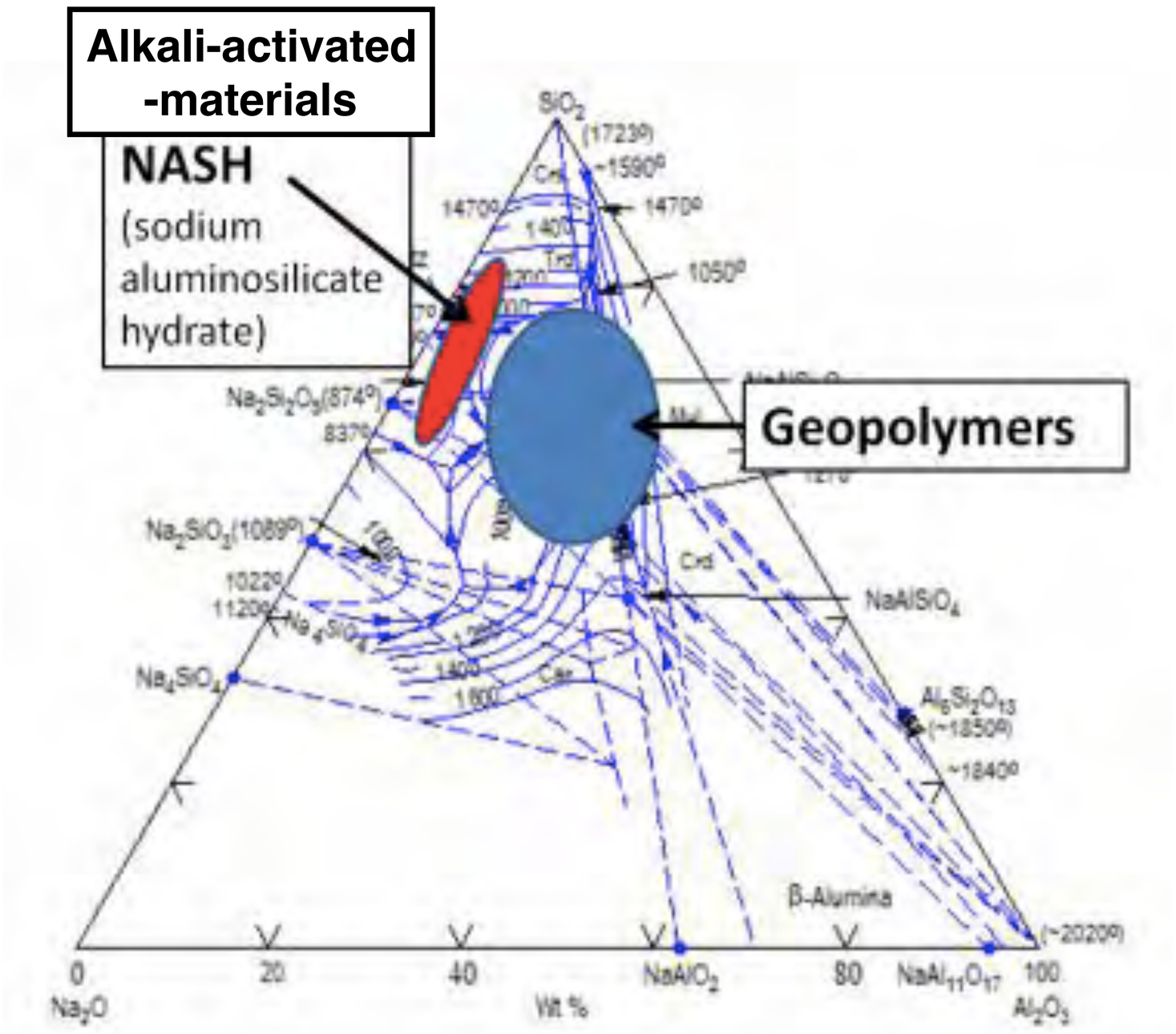
Classification of Alkali-Activated-Materials AAM according to J.L. Provis / RILEM and the small area devoted to Geopolymers

Prof. Waltraud M. Kriven

University of Illinois

at Urbana-Champaign, USA

Relationship between Alkali Activated Cements and Geopolymers



Prof. Waltraud M. Kriven
University of Illinois
at Urbana-Champaign, USA

e-mail:

"On a separate note, I have observed in the last 4-5 years of learning about geopolymers (mainly from your book) that there is some competition in the research publication world about who gets to define on what is a "geopolymer".

Although you coined this name in the 70s and make clear the chemical and performance difference between Portland based alkali-activated materials and geopolymers (very clearly described in the Webinars) as you know, some editors and reviewers are exclusively relying on the RILEM Technical Committees definitions of alkali-activated cements and alkali-activated materials.

This leads some reviewers to reject papers based on the genuine geopolymer terminology and chemical mechanisms. As such, people wanting to be published, eventually end up adapting the "recommended" terminology. I give this as feedback."

Contents lists available at ScienceDirect

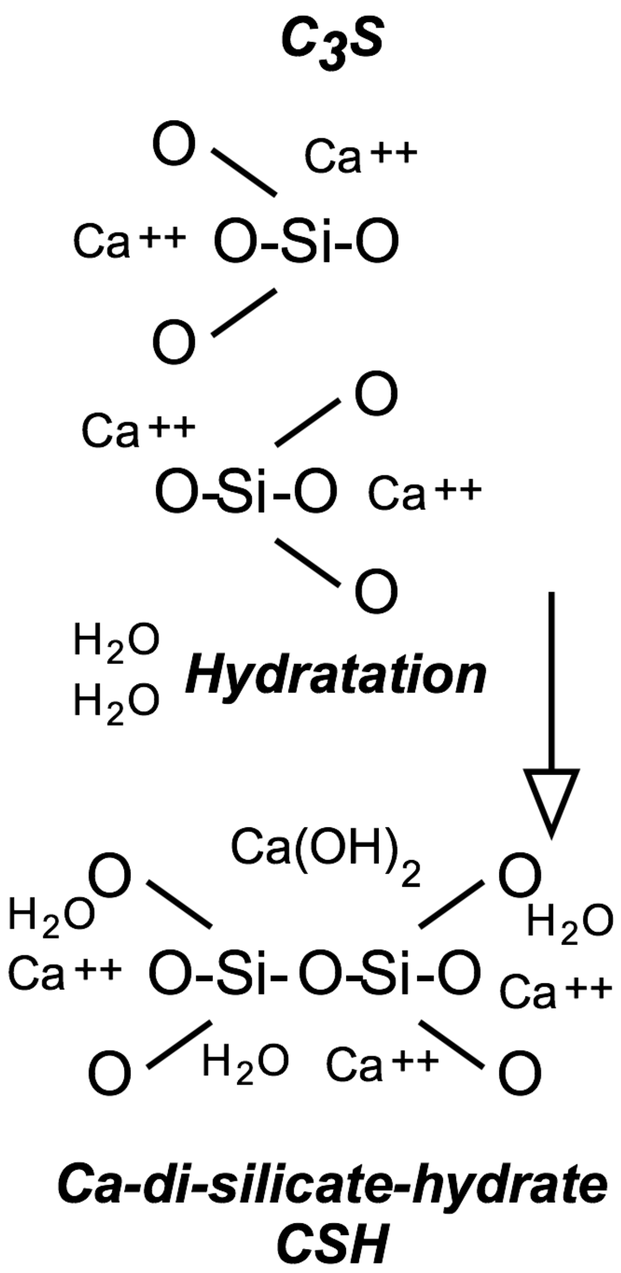
Cement and Concrete Research

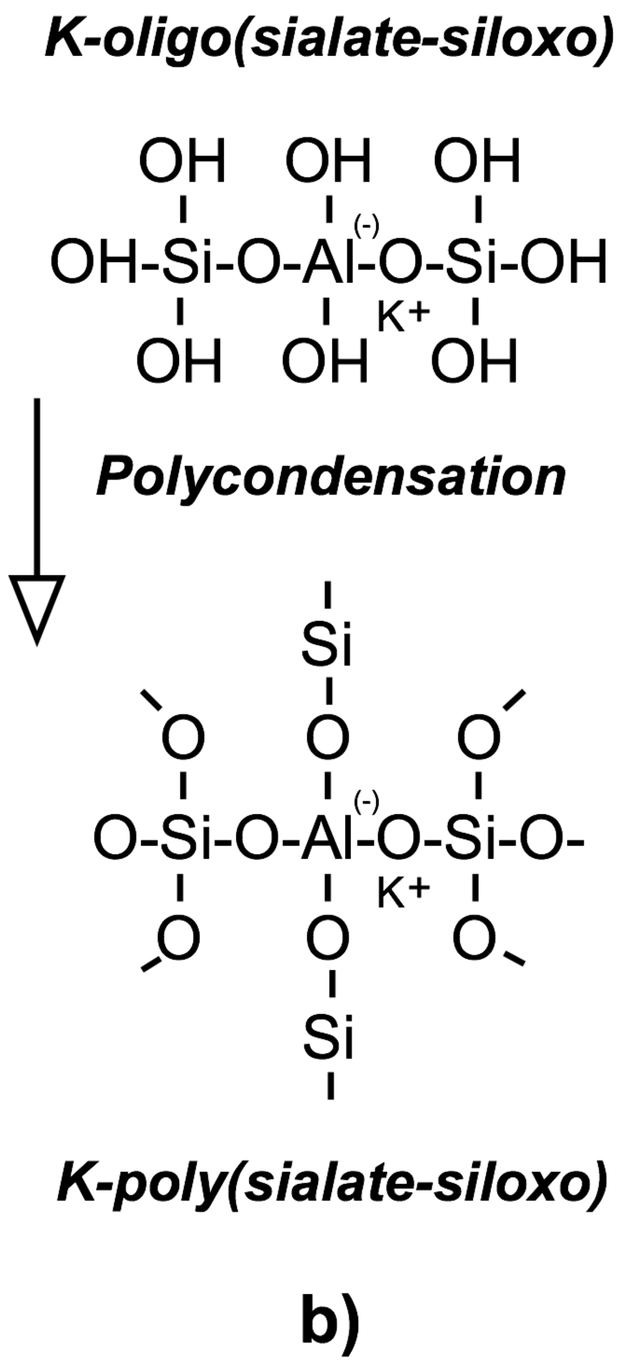
journal homepage: http://ees.elsevier.com/CEMCON/default.asp

RILEM/ Technical Committee Alkali-Activated-Materials, 2014 Report, J. L. Provis and al.

Geopolymer is a **Polymer Chemistry** *(poly-sialate)*

and **NOT** a Calcium Hydrate alternative.





Alkali-activated Materials **are not POLYMERS**.

They **cannot be called GEO-POLYMERS**

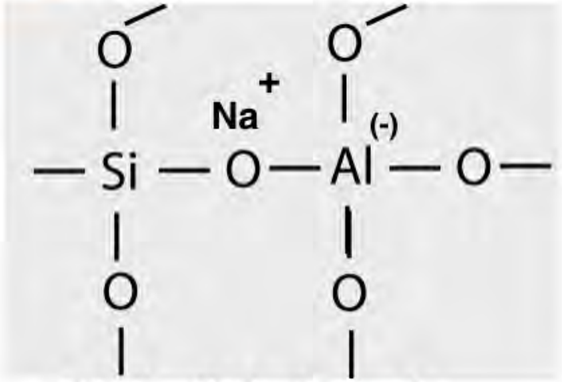
2 very different systems!

It is a big scientific mistake to use both as synonyms.

Alkali-activation is a wrong terminology for geopolymers.

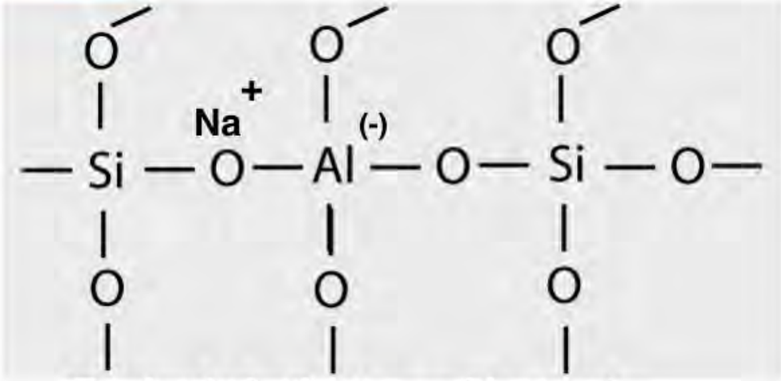
1979 Geopolymer Terminology

Si: Al = 1:1



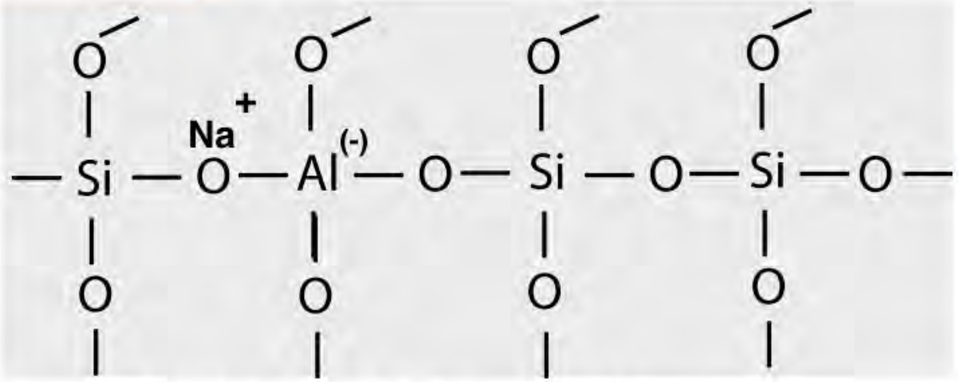
Poly(sialate)

Si: Al = 2:1



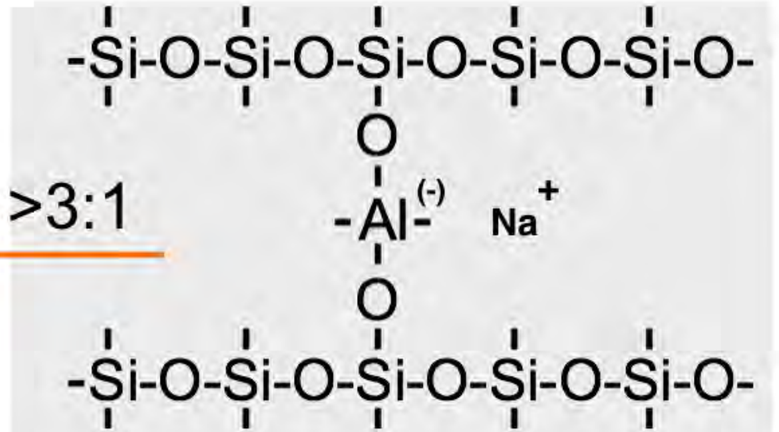
Poly(sialate-siloxo)

Si: Al = 3:1

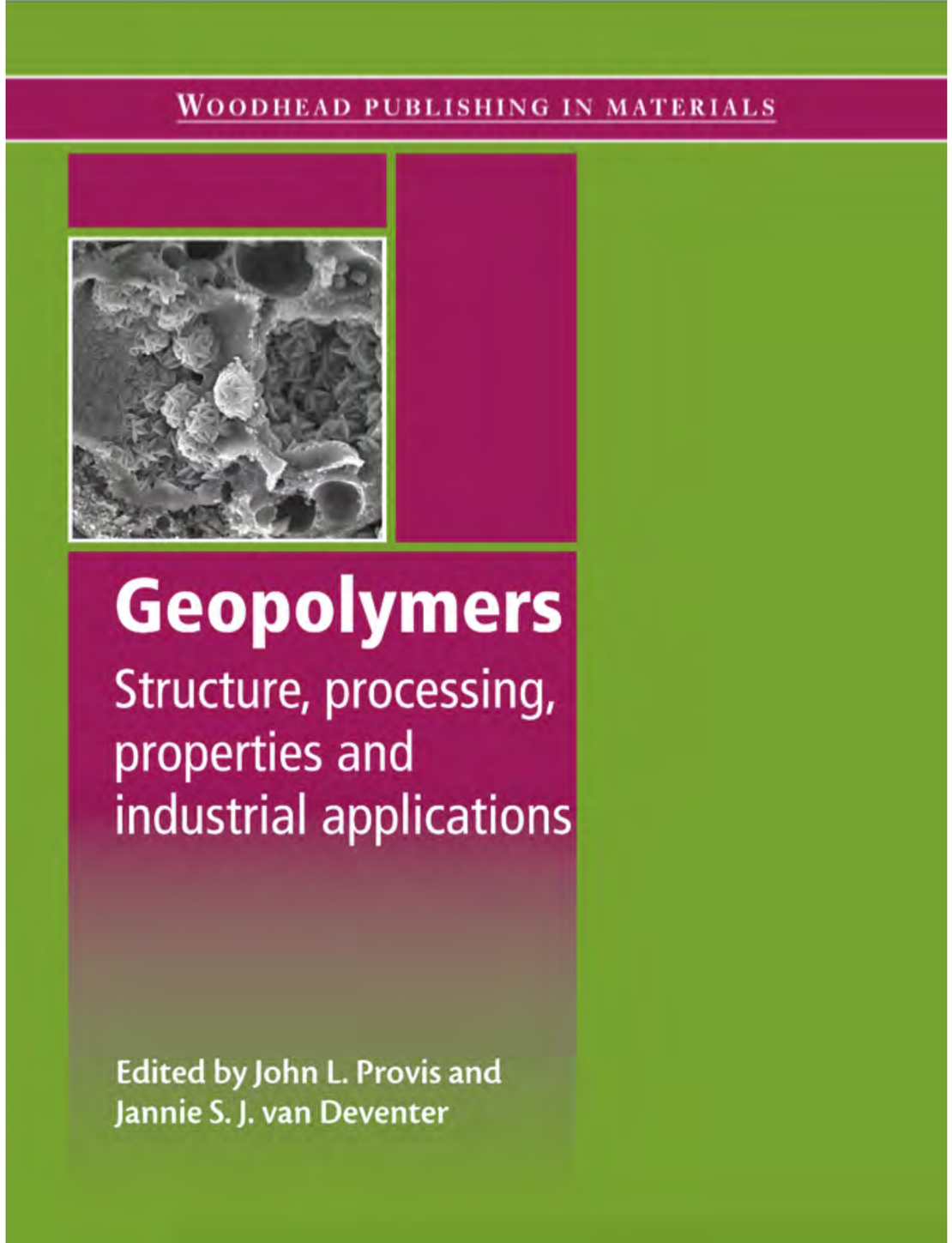


Poly(sialate-disiloxo)

Si: Al >3:1



Sialate link



However, for J. L. Provis:

These oligomers are named by some geopolymer chemists as "sialates" following the scheme developed by Davidovits, although this terminology is not universally accepted within the research community

*due in part to confusion with the earlier (1952) use of the same word to refer to the salts of the important biomolecule sialic acid, that was derived from an ancient Greek word meaning '**saliva**'.*

———————————————————————.

Geopolymer

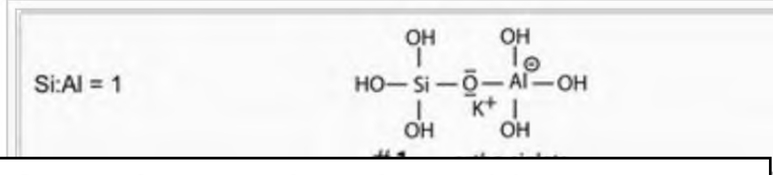
January, 2016

From Wikipedia, the free encyclopedia

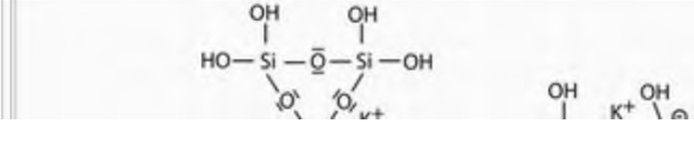
Geopolymers are inorganic, typically ceramic, materials that form long-range, covalently bonded, non-crystalline (am
naturally-occurring geopolymer.[*citation needed*] Commercially produced geopolymers may be used for fire- and heat-resi
applications, high-temperature ceramics, new binders for fire-resistant fiber composites, toxic and radioactive waste e

Geopolymerization starts with oligomers [edit]

Geopolymerization is the process of combining many small molecules known as oligomers into a covalently bonded network. The geo-chemical syntheses are carried out through oligomers (dimer, trimer, tetramer, pentamer) which are believed to contribute to the formation of the actual structure of the three-dimensional



These oligomers are named by some geopolymer chemists as *sialates* following the scheme developed by Davidovits,[1] although this terminology is not universally accepted within the research community due in part to confusion with the earlier (1952) use of the same word to refer to the salts of the important biomolecule sialic acid.[14] In 2000, T.W. Swaddle and his team[15] proved the existence of soluble isolated alumino-silicate



Indeed, it was discovered that the polymerization at room temperature of oligo-sialates was taking place on a time scale of around 100 milliseconds, i.e. 100 to 1000 times faster than the polymerization of ortho-silicate,

Geopolymer terminology based on Geology; for >100 years term ’SIALIC’ : “***sialic*** metamorphic rocks”, example:

the oceanic crust is mostly basaltic and the continental crust is mostly ***sialic***, meaning the rocks, such as granite, contain high amounts of aluminum and silica.

Coal-Fly ashes are commonly classified into 3 entities ***for >90 years***

- calcic-,
- ferric- and
- sialic-groups;

the sialic component results from the %weight of (SiO_2 + Al_2O_3 + TiO_2).

The well known term ‘SIALON’, for high temperature refractory materials, acronym of silicon-aluminum-oxo-nitride, i.e. a scientific logical terminology.

The geopolymeric ‘SIALATE’ proceeds from the same scientific logic (it is the salt of the silico-aluminic acid, ***sialic*** rocks).

In fact, for geopolymer molecules, we write (sialate-siloxo), (sialate-disiloxo), poly(sialate), poly(sialate-siloxo), poly(sialate-disiloxo), never used in biochemistry.

What is a geopolymer ?

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

-Si-O-Si-O- siloxo, poly(siloxo)

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

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

-Si-O-Al-O-Si-O-Si-O- sialate-disiloxo, poly(sialate-disiloxo)

-P-O-P-O- phosphate, poly(phosphate)

-P-O-Si-O-P-O- phospho-siloxo, poly(phospho-siloxo)

-P-O-Al-O-P-O- phospho-aluminate,

-R-Si-O-Si-O-R- organo-siloxo, poly-silicone

What is a geopolymer ?

not alkali-activated compound

no AAMK

no AAFA

no AAS

no AAxxxx

Geopolymerization

in **alkaline** or **acidic** medium

Geopolymers

high molecular, macromolecules, polymers

Alkali-activated Materials **are not POLYMERS**.

They **cannot be called GEO-POLYMERS**

2 very different systems!

It is a big scientific mistake to use both as synonyms.

Alkali-activation is a wrong terminology for geopolymers.

AAC

alkali-activated concrete

AAFA

alkali-activated fly ash

AAFAC

alkali-activated fly ash concrete

“Are there some other activators instead of NaOH ?”

First: there is no geopolymer “***activator***”.
There is a “***reagent***” (reactive ingredient) or “***hardener***”;
alkalis (NaOH, KOH, LiOH), Na-silicates, K-silicates

Second: there is ***NOTHING to activate.***
Metakaolin MK-750 is by nature *super-reactive*;
glass in fly ash is *easy to depolymerize*, etc.

Alkali-activation
first step of geopolymerization?

1. ~~alkali-activation~~ (*alkalination*)
2. Depolymerization of silicates
3. Gel formation of oligo-sialates
4. Polycondensation
5. Reticulation, networking
6. Geopolymer solidification

Alkalination, i.e. chemical reaction between alkali and other reagents, is a well known process going back to Antiquity

QUIZ GAME

AAPF

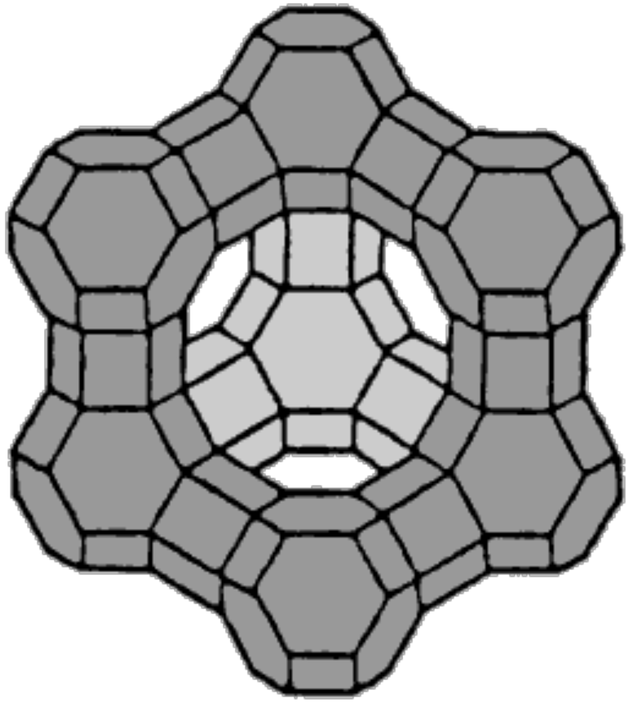
alkali-activated phenol / formaldehyde

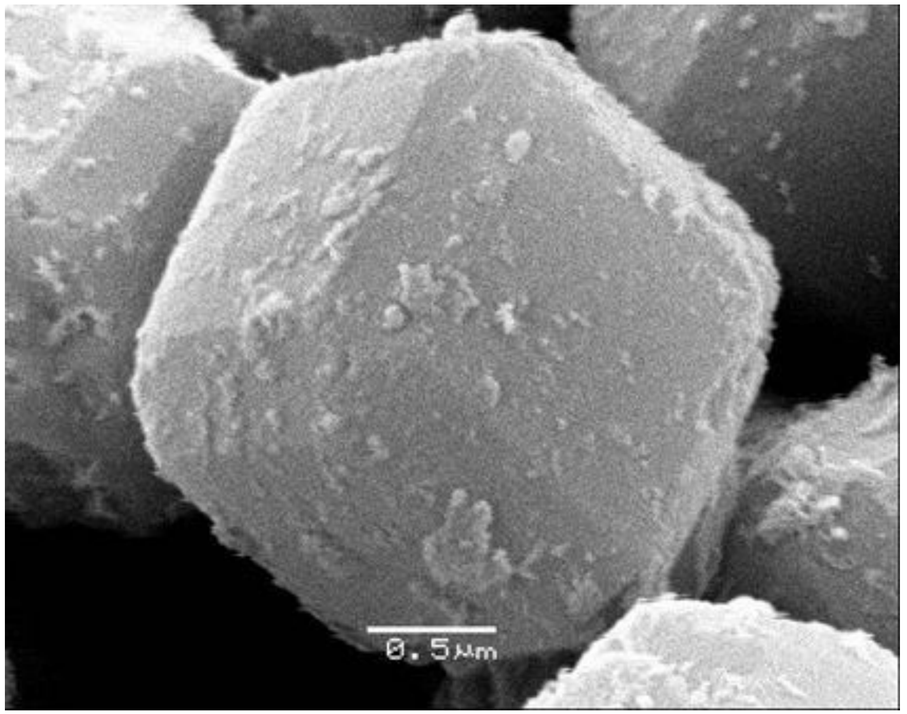
BAKELITE, polycondensation, phenoplast

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.

For many cement scientists:

Alkalination = Alkali Activation

Wrong

All the previous examples would have been called **AAxx** by today's Portland cement scientists, especially by those who are simply replacing Ca^{++} by Na^{+} and, like for *C-S-H*, call it *N-A-S-H*.

Whereas, they are actually named:

- Bakelite *(poly-phenol)*,
- Zeolite *(poly-silicoaluminate)*,
- Viscose *(poly-cellulose)*,
- Aluminum,
- Soap *(Na-glycerol)*.

To sum up:

First: there is no geopolymer "***activator***".

There is a "***reagent***" (reactive ingredient) or "***hardener***";

soluble silicates: Na-silicates, K-silicates, etc.

Second: there is ***NOTHING to activate.***

Metakaolin MK-750 is by nature *super-reactive*;

glass in fly ash is *easy to depolymerize*, etc.

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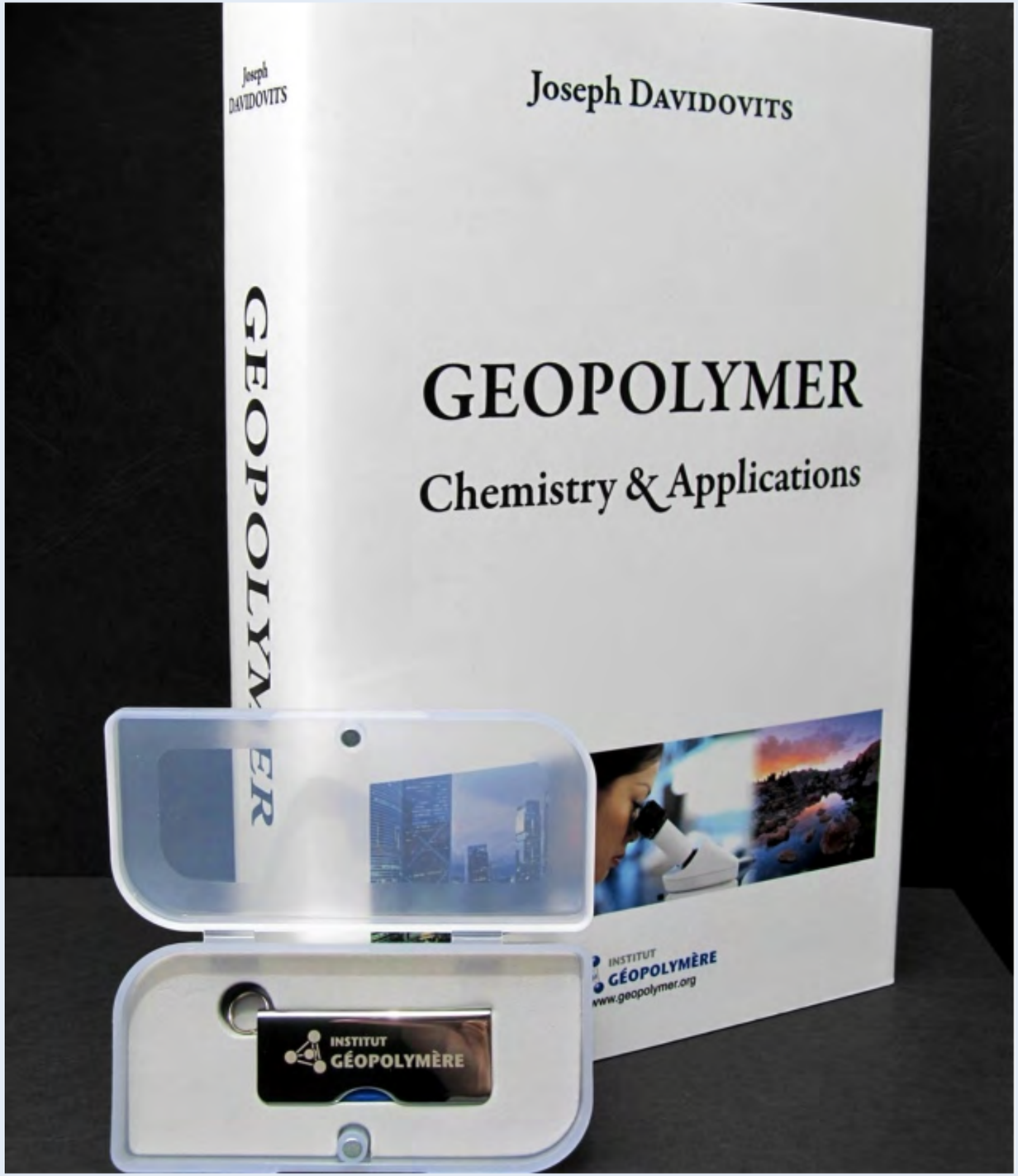
It is a big scientific mistake to use both as synonyms.

Alkali-activation is a wrong terminology for geopolymers.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4th edition

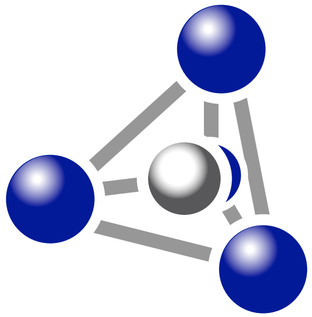
State of the Geopolymer R&D 2016

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology



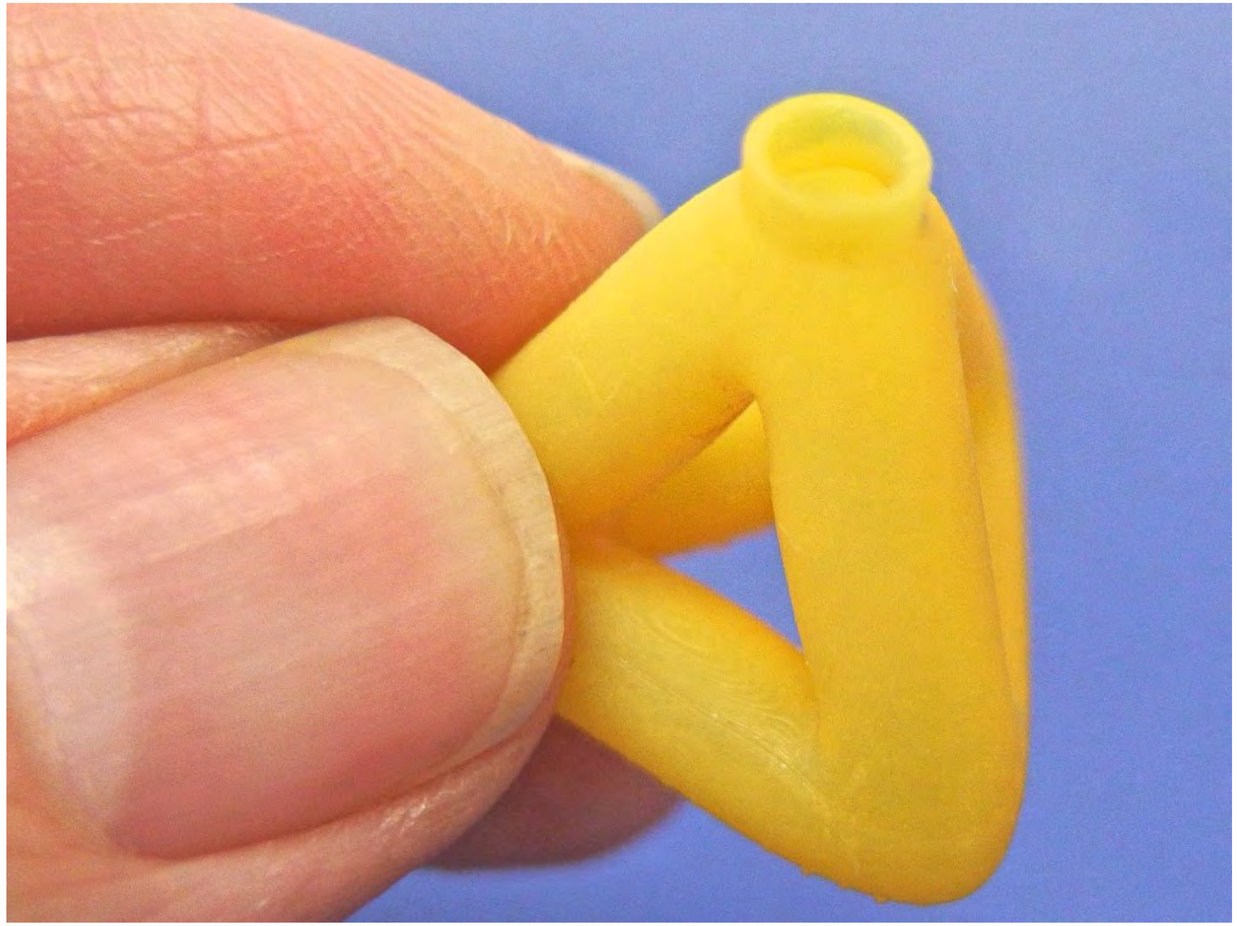
2016

GeopolymerCamp

Tuesday, July 5, 2016

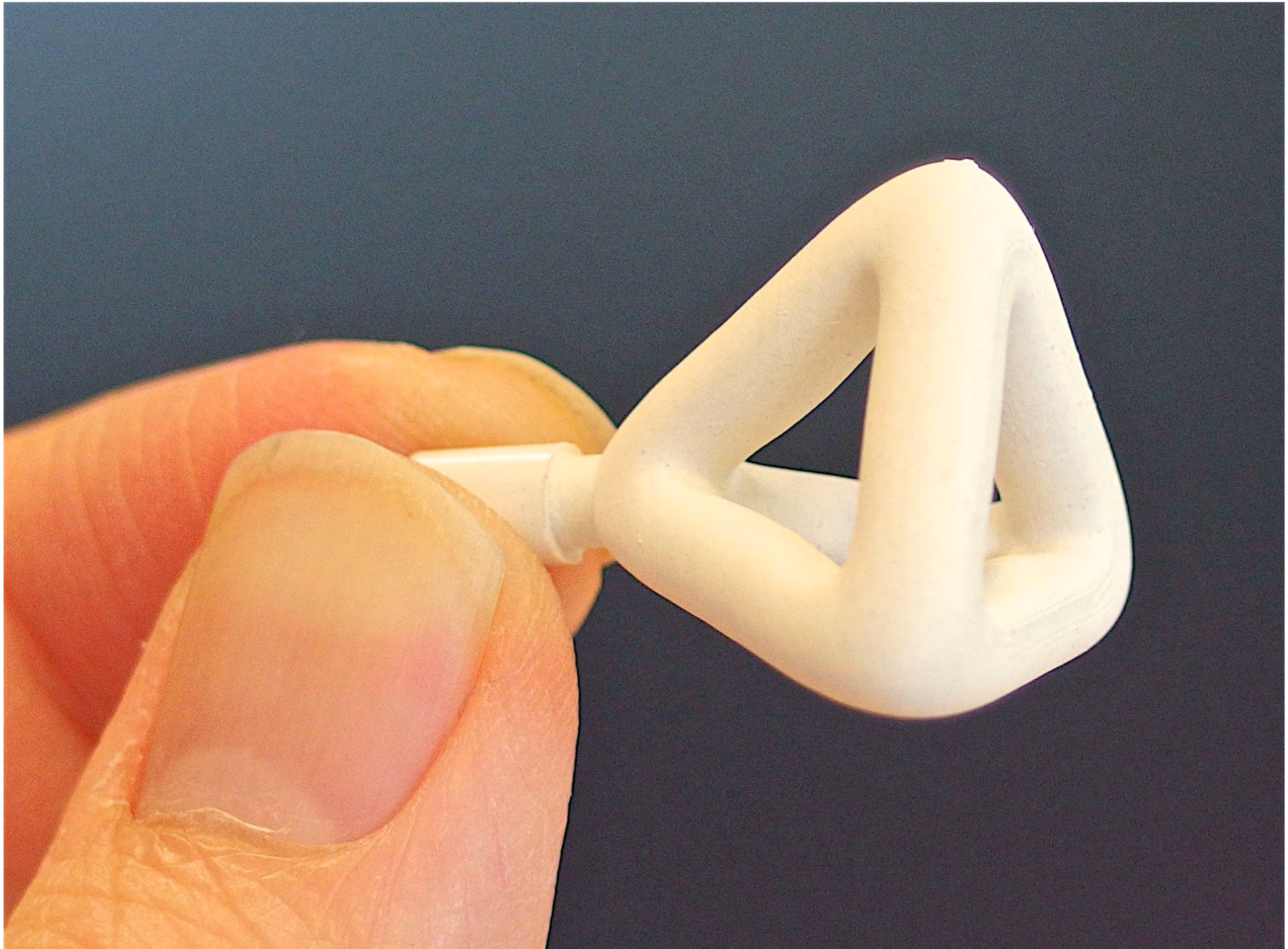
Focused session

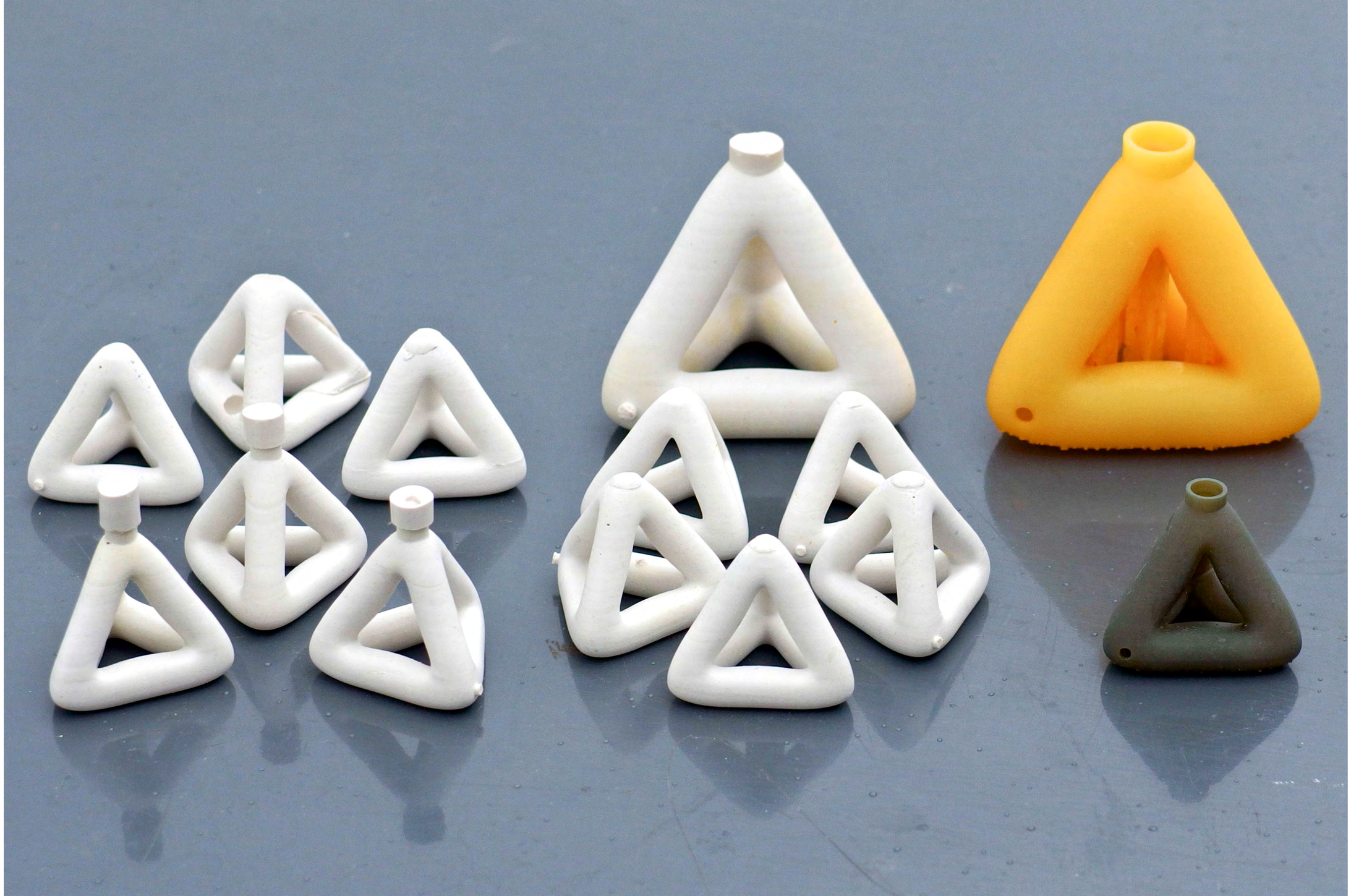
3D-printing



Organic photopolymer mold
3D-print

K-poly(sialate-siloxo)
geopolymer ceramic





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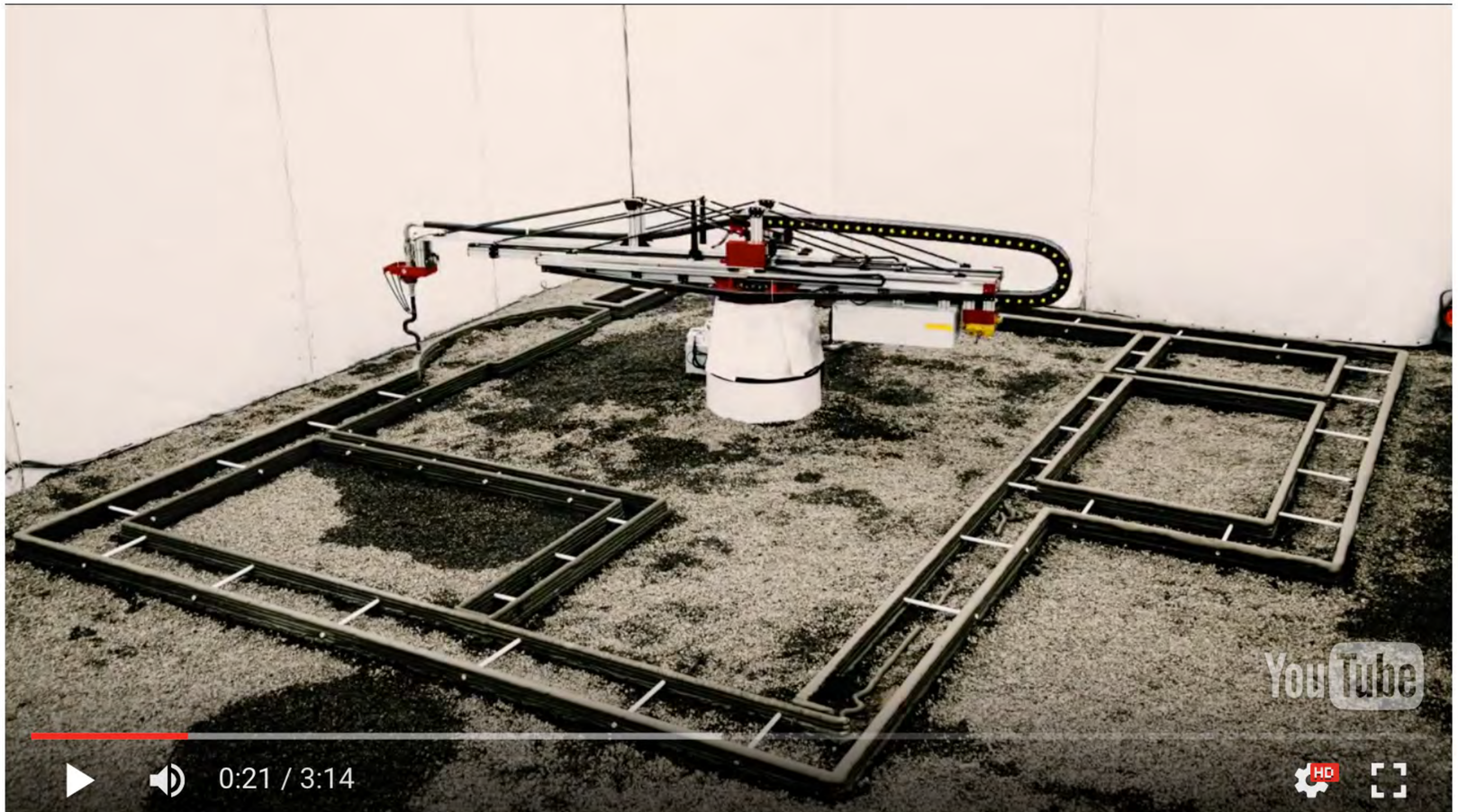
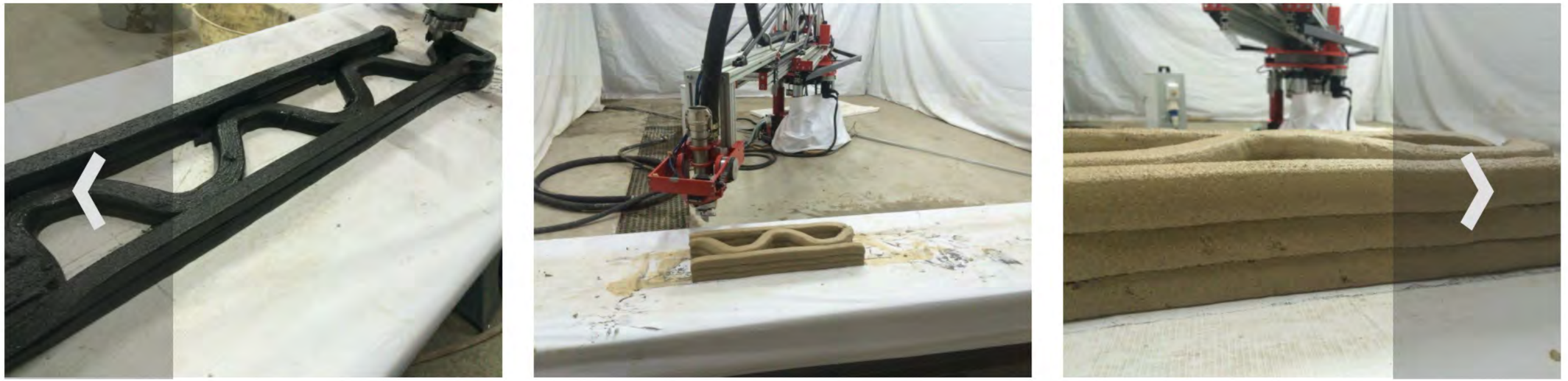


Apis Cor plans to print houses using Geopolymer in future

2016-01-27

Apis Cor engineers have met with Russian-Italian company “RENKA RUS” to research possibilities of using Geopolymer in construction 3D printing. Geopolymer features an exceptional strength and efficiency. It doesn’t pollute the environment when used. There is a high probability that it will become one of the other construction materials to be used for the house printing.



During the meeting engineers tested the material for purity and hardening speed.

GEOPOLYMER INSTITUTE

News

3rd Virtual Journal on Geopolymer Science

May 31 2016

The third issue of what will become the Virtual Journal on Geopolymer Science is online at

Reinforced Geopolymer Composites

A critical review

.

The *Virtual Journal on Geopolymer Science* is a collection of already published research

Reinforced Geopolymer Composites: A critical review

31 May 2016 | Joseph Davidovits

31 May 2016

This critical review is the follow up of two feature articles titled ***Geopolymers based on natural and synthetic metakaolin,*** *(*on line *on* 17 January 2016) and ***Environmental implications of Geopolymers,*** (online on 20 June 2015). It has been written in compliance with a decision of Elsevier and Geopolymer Institute to join forces, distill and distribute the best research publications contained in their combined archives, through a series of **Elsevier-Geopolymer Institute Virtual Special Issues on Geopolymer Science**. On line 29 June 2015.

The invention of mineral geopolymers of the types poly(sialate) -Si-O-Al-O- (Si:Al=1), poly(sialate-siloxo) -Si-O-Al-O-Si-O- (Si:Al=2), poly(sialate-disiloxo) -Si-O-Al-O-Si-O-Si-O- (Si:Al=3), poly(sialate-multisiloxo) (Si:Al>>3) goes back to 1972, when, in the aftermath of various catastrophic fires in France causing hundreds of casualties in public buildings which involved common organic plastic, research on non-flammable and non-combustible plastic materials became our priority.

We founded a private research company in 1972, Cordi SA (called later Cordi-Géopolymère), to develop new inorganic fire-resistant polymer materials which we called «geopolymers» (mineral polymers resulting from geochemistry or geosynthesis). We knew that we would not reach fire resistance and zero toxicity with organic chemistry. When, ten years later, we started the development of a geopolymer matrix composite concept, the objective was to fabricate molding tools and patterns, to replace metal tooling for small production runs in the plastic processing industry and the foundry industry. The targeted working

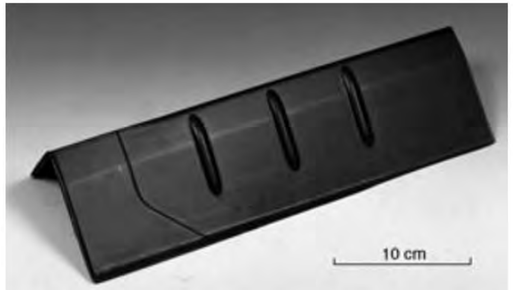


Figure 1a: K-poly(sialate-multisiloxo)-carbon-fiber-composite

Features

Polymers and soft materials

Nanomaterials

Surface science

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REVIEW

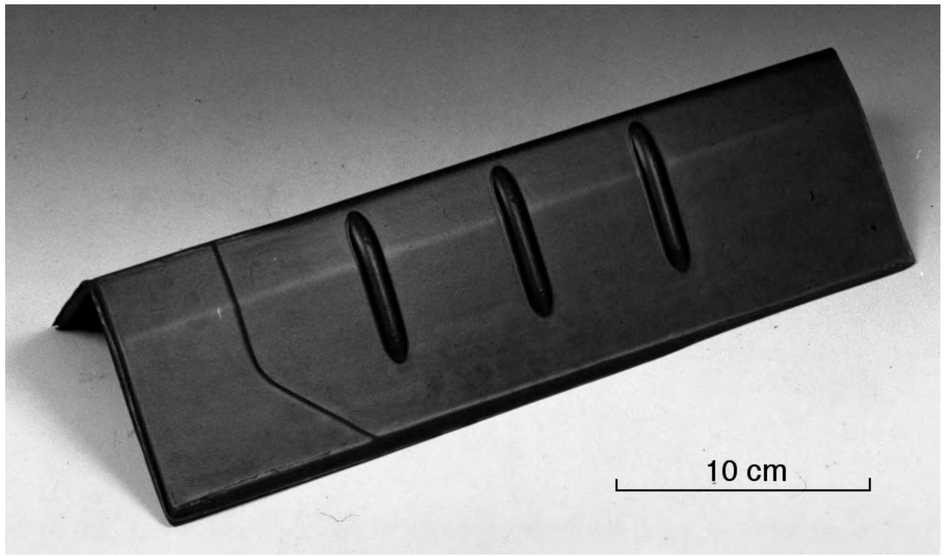
Additive manufacturing of multi-directional preforms for composites: opportunities and challenges

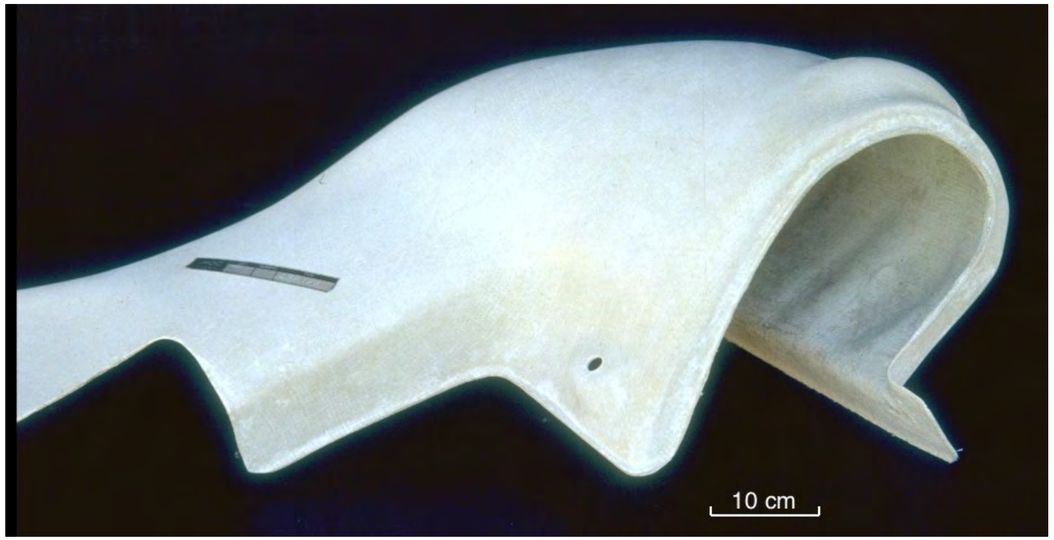
Volume 18, Issue 9, Pages 503–512 | Zhenzhen Quan, Amanda Wu, Michael Keefe, Xiaohong Qin, Jianyong Yu, Jonghwan Suhr, Joon-Hyung Byun, Byung-Sun Kim, Tsu-Wei Chou

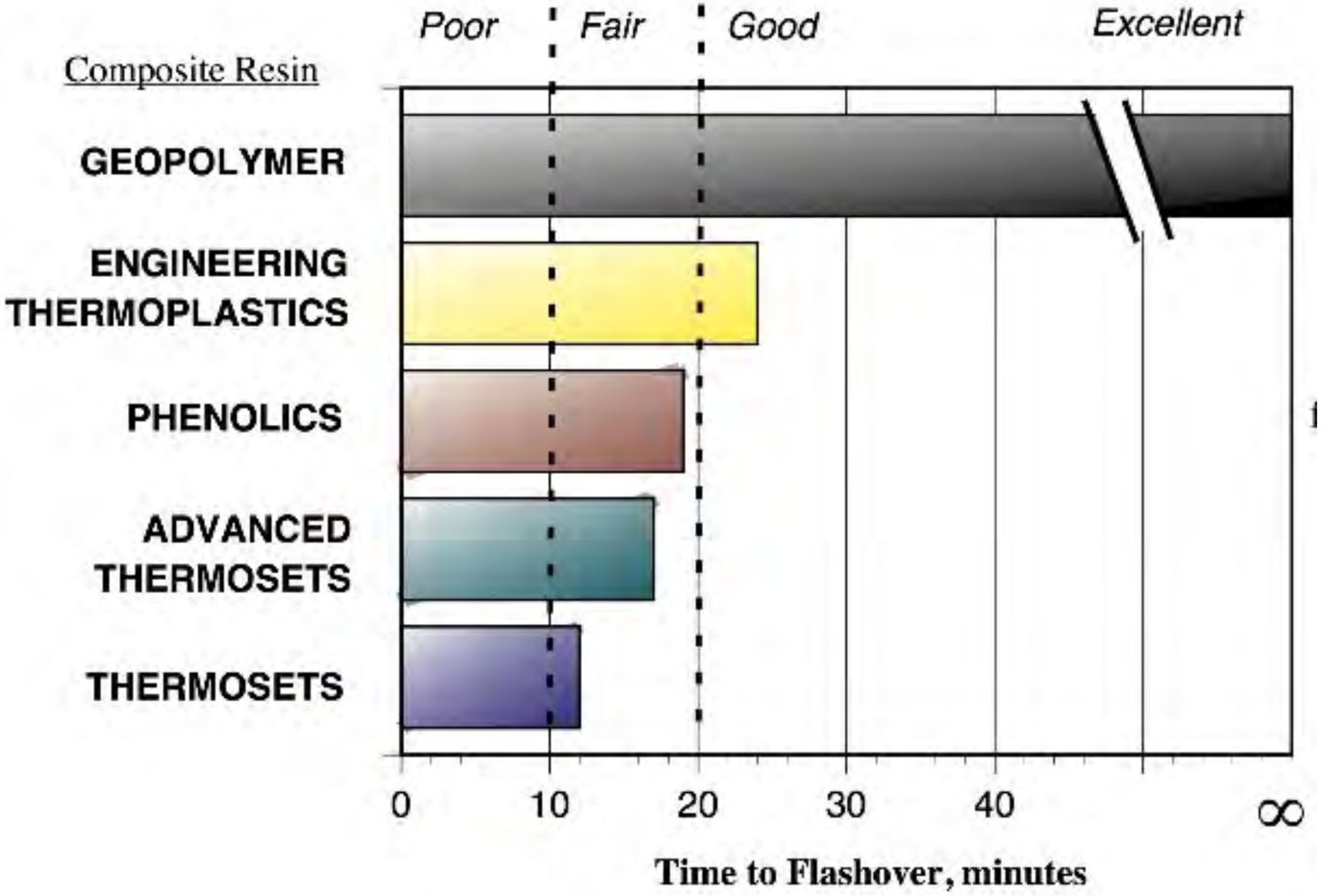
Comment now

JOURNAL

Geopolymer-fiber-composites: heat and fire resistance







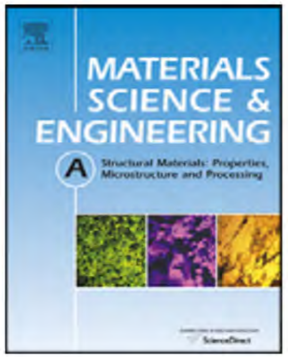
Fiber-reinforced geopolymers

Materials Science and Engineering A 497 (2008) 181–185

Contents lists available at ScienceDirect

Materials Science and Engineering A

journal homepage: www.elsevier.com/locate/msea



Effects of fiber length on mechanical properties and fracture behavior of short carbon fiber reinforced geopolymer matrix composites

Tiesong Lin, Dechang Jia*, Peigang He, Meirong Wang, Defu Liang

Institute for Advanced Ceramics, Harbin Institute of Technology, Harbin 150001, People's Republic of China

K-poly(sialate-siloxo) geopolymer
+
carbon short fibers
2mm, 7mm, 12mm
length

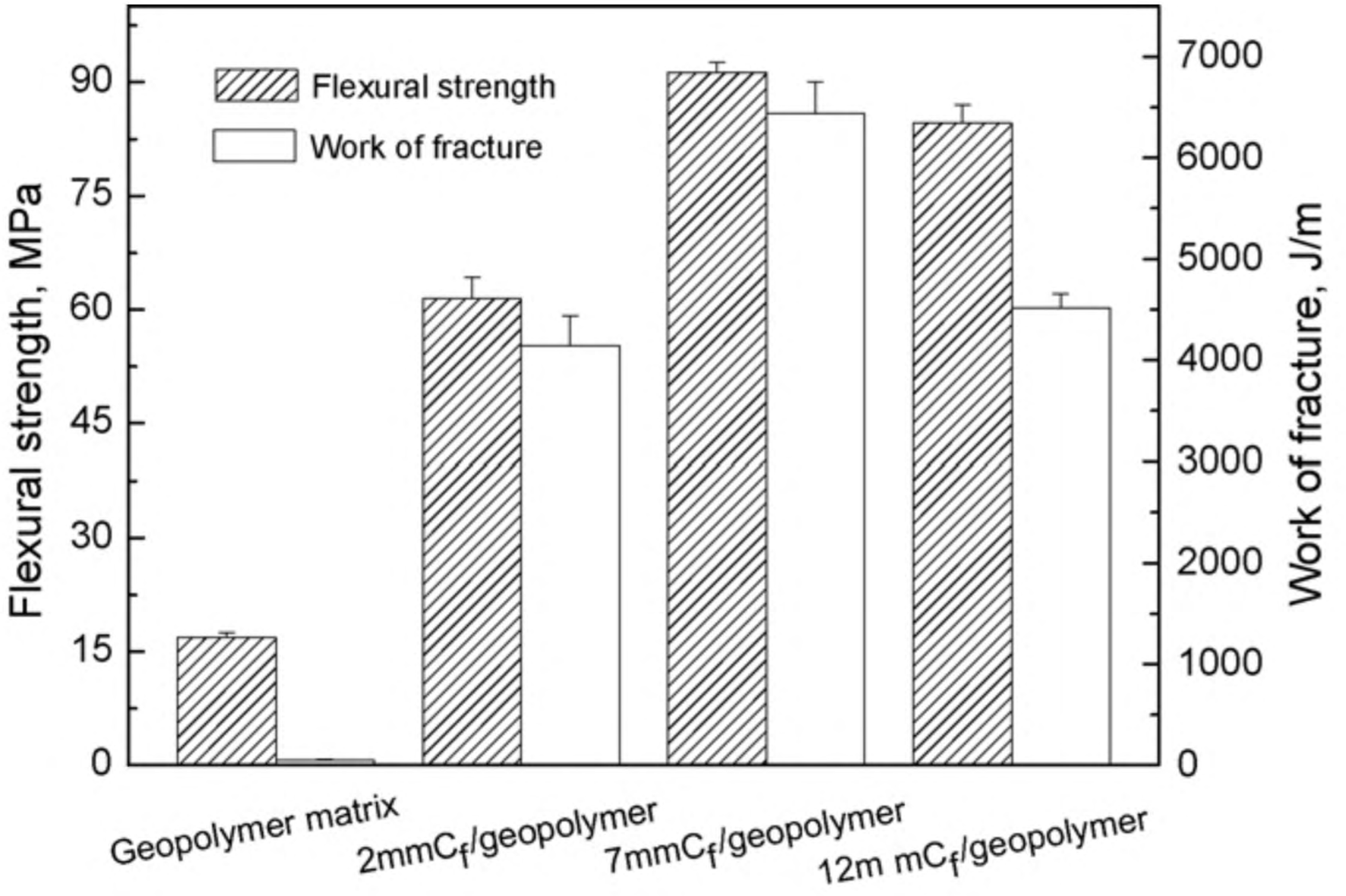


Fig. 6. Variation of flexural strength and work of fracture of geopolymer matrix and C_f/geopolymer composites vs starting fiber length.

Journal of the European Ceramic Society 36 (2016) 2601–2609

Contents lists available at www.sciencedirect.com

Journal of the European Ceramic Society

journal homepage: www.elsevier.com/locate/jeurceramsoc

Crystallization kinetics and microstructure evolution of reduced graphene oxide/geopolymer composites

Shu Yan[a,b], Peigang He[a,b,*], Dechang Jia[a,b,*], Xiaoming Duan[a,b], Zhihua Yang[a,b], Shengjin Wang[a,b], Yu Zhou[a,b]

[a] *Institute for Advanced Ceramics, Harbin Institute of Technology, Harbin 150080, China*
[b] *School of Materials Science and Engineering, Harbin Institute of Technology, Harbin 150080, China*

Homogeneously dispersed graphene reinforced geopolymer castables were easily and simply prepared through in-situ reduction of graphene oxide (GO) in the alkaline silicate solutions. The in-situ graphene oxide reduction occurs at 60 °C for 72 h. The as-obtained graphene is uniformly dispersed and added to metakaolin, ultrasonically mixed and polycondensed at 60 °C.

The final amorphous geopolymer matrix is of the type K-poly(sialate-siloxo). ….The ***flexural strength*** at room-temperature for the ***1 wt% graphene*** - K-poly(sialate-siloxo) geopolymer composite is in the range of 10-15 Mpa.

After heat - treatment at 950 °C for 30 minutes, ***flexural strength*** reaches **75 Mpa.** Yet, it is not stable at this temperature. For longer heat-treatment time, the strength decreases due to the oxidation of the graphene nano-sheets.

Materials Letters 65 (2011) 880–883

Contents lists available at ScienceDirect

Materials Letters

journal homepage: www.elsevier.com/locate/matlet

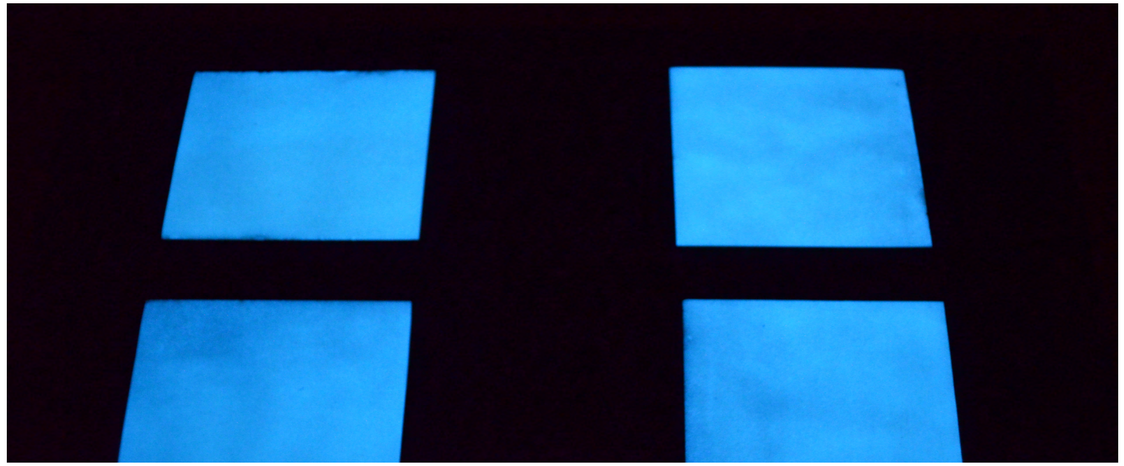
Effect of porosity on the absorbed, reemitted and transmitted light by a geopolymer metakaolin base

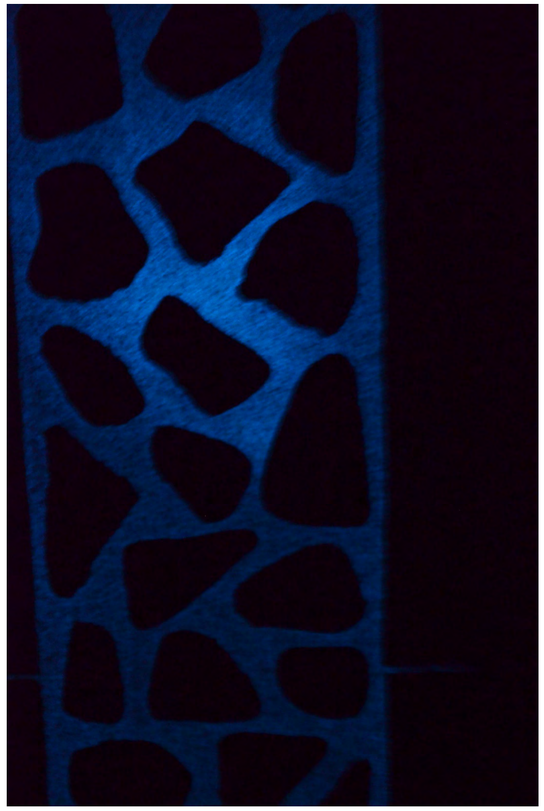
Gasca-Tirado J. Ramón [a,*], Rubio-Ávalos J.C. [b,c], Muñiz-Villarreal M.S. [a], Manzano-Ramírez A. [a], Reyes-Araiza J.L. [c], Sampieri-Bulbarela S. [a], Carlos Villaseñor-Mora [d], Pérez-Bueno J.J. [e], Apatiga L.M. [f], Amigó Borrás Vicente [g]

[a] Centro de Investigaciones y de Estudios Avanzados del I.P.N. Unidad Querétaro, Querétaro, Querétaro, C.P. 76230, Mexico
[b] Faculty of Civil Engineering, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, C.P. 58000, Mexico
[c] Postdoctoral position at Centro de Investigaciones y de Estudios Avanzados del I.P.N. Unidad Querétaro, Querétaro, Querétaro, C.P. 76230, Mexico
[d] Universidad de Guanajuato. Campus Celaya-Salvatierra, Celaya, Guanajuato, C.P. 38060, Mexico
[e] Centro de Investigación y Desarrollo Tecnológico en Electroquímica, Parque Tecnológico Querétaro-San Fandila, C.P. 76700, San Fandila, Pedro Escobedo, Querétaro, Mexico
[f] Centro de Física Aplicada y Tecnología Avanzada, Universidad Nacional Autónoma de México, A.P. 1-1010, Querétaro, Mexico
[g] Instituto de Tecnología de Materiales, Universidad Politécnica de Valencia. Camino de Vera, s/n. C.P. 46022, Valencia Spain

The photoluminescent crystals (pigment NGX-19) were obtained from DayGlo Color Corp. USA. It was determined by XRD and SEM that those crystals were $Sr_2MgSi_2O_7$: Eu^{2+} Dy^{3+} with an average particle size of 2.8 µm.

The photoluminescent geopolymer after sun exposure shows that those optical properties are real and can be expanded if applications are chosen to be performed at wavelengths lower than 570 nm. It lasts 8-12 hours.





Jose-Carlos Rubio-Avalos, Ph.D.

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1) Geopolymer science

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First structural geopolymer concrete (Wagners, 2013)

Global Change Institute, Univ. Queensland, Brisbane, Australia

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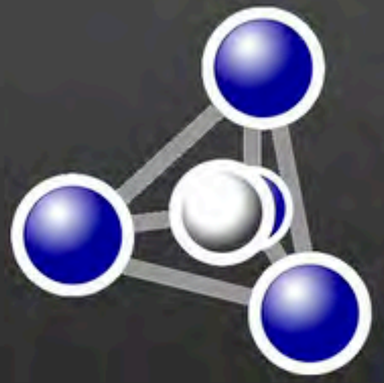
Visit by Prof. Joseph DAVIDOVITS of the first public building made out of structural geopolymer concrete with Wagners' Earth Friendly Concrete® (EFC)

Toowoomba-Brisbane-West Wellcamp Airport, by WAGNERS, Australia

October 2015

100,000 tonnes

Slag/fly ash-based geopolymer concrete EFC (Earth Friendly Concrete)



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Visit by Prof. Joseph DAVIDOVITS of the first airport made out of geopolymer cement with company Wagners' Earth Friendly Concrete® (EFC)

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Environmental implications of Geopolymers

29 June 2015 | Joseph Davidovits

How should we consider geopolymers? Many scientists and civil engineers are mistaking alkali-activation for geopolymers, fuelling confusion, using them as synonyms without understanding what they really are. We find in the literature either LCAs of geopolymer cements/concretes or LCA of alkali-activated-materials. The latter encompass the specific fields of alkali-activated slags, alkali-activated coal fly ashes, alkali-activated blended Portland cement.

A dedicated Geopolymer Institute video deals with the major differences prevailing between alkali-activated-materials and geopolymer cements: *Why Alkali-Activated Materials are NOT Geopolymers?* **http://www.geopolymer.org/faq/alkali-activated-materials-geopolymers**. First, we explain the main differences between alkali-activated-concrete, alkali-activated-slag, alkali-activated-fly ash on one hand and Slag-based Geopolymer cement on the other hand, in terms of chemistry, molecular structure, long-term durability. In a second part, we comment the industrialization of Slag/fly ash-based geopolymer cement/concrete by the company Wagners, Australia, and we focus on the results provided by the

FEATURED ARTICLES, TECHNICAL PAPERS

24 False CO2 Values Published in Scientific Papers

Mar 19, 2016 |

Technical paper #24 False Values on CO2 Emission for Geopolymer Cement/Concrete Published in Scientific Papers Adapted from the article originally published in Elsevier's internet site "Materials Today" at Environmental Implications of Geopolymers, 29 June 2015. See also the presentation at the Geopolymer Camp 2015. See also the news Virtual Journal on Geopolymer Science . LCA of commercialised [...]

Journal of Cleaner Production 19 (2011) 1229–1238

Contents lists available at ScienceDirect

Journal of Cleaner Production 2011

journal homepage: www.elsevier.com/locate/jclepro

An environmental evaluation of geopolymer based concrete production: reviewing current research trends

G. Habert [a,*], J.B. d'Espinose de Lacaillerie [b], N. Roussel [a]

[a] *Université Paris-Est, IFSTTAR, Département Matériaux, 58 bd Lefebvre, 75732 Paris cedex 15, France*
[b] *Ecole Supérieure de Physique et Chimie Industrielles, PPMD SIMM, UMR 7615 ESPCI-CNRS-UPMC, 10 rue Vauquelin, 75231 Paris cedex 05, France*

They claimed that, in terms of CO_2 emission, geopolymer cement was not better than Portland cement, and worse for other parameters.

One of their studies involved a mix design containing metakaolin MK-750 and Na-silicate and, because of the high amount of alkali silicate needed in the formulation, they claimed that geopolymer cement emitted twice the amount of Portland cement. This statement was taken for granted by other scientists without any further consideration.

The CO_2 emissions and environmental impacts calculated in Habert et al. paper are wrong and must be roughly divided by 2.6 (**260% too high).**

RILEM Technical Letters (2016) 1: 17 – 23 **April 2016**

RILEM technical letters

Recent update on the environmental impact of geopolymers

Guillaume Habert[a*], Claudiane Ouellet-Plamondon[b]

[a] Chair of Sustainable Construction, Swiss Federal Institute of Technology Zurich (ETH Zurich), Stefano Franscini Platz 5, 8093 Zurich, Switzerland
[b] Department of Construction Engineering, École de Technologie Supérieure, 1100 Notre-Dame West, Montréal (Québec) H3C 1K3, Canada

The release of the new Ecoinvent version 3 ……. pushes to recalculate previous data that were calculated with a too high value for the sodium silicate solution, as Davidovits mentioned in his recent review [19].

The updated results, with a sodium silicate solution impacts divided by nearly 3 ……. improve the comparison with cementitious materials. In particular MK-based geopolymer have now similar GWP [CO2] as blended cement based concrete.

(K-Ca) geopolymer cements

Evolution since 1983-85.

MK-750 / Slag / K-silicate % by weight of geopolymeric formulation

MK-750-based

	Pyrament (1985)	Geopolymite 50 (1987)	Rock-based (1997) 100 MPa	Rock-based (2002) 50 MPa	Fly Ash-based (2006) 100 MPa	Fly Ash-based (2006) 40 MPa
MK-750	40 %	40 %	rock 60 % (MK=20)	rock 60 % (MK=20)		
K-silicate	30 %	30 %	20-22%	17 %	14 %	10 %

GP-Book: Chapter 9

GP-Book: Chapter 10
Chapter 24

GP-Book: Chapter 12

State of the Geopolymer R&D 2016

Joseph Davidovits