SCIENCE AND TECHNOLOGY

ASPHALT SHINGLE AND SBS MEMBRANE ROOFS

AN INTRODUCTION

Nanosilica modified asphalt

A decade of science

Although GoNano is the first and currently only North American company offering a nanotechnology solution to enhance, protect and increase lifespan of asphalt shingle roofs, the science of nanosilica modified asphalt pavements spans a decade back and benefits from hundreds of scientific studies and testing.

Scientific evidence

Major scientific institutes have been studying and testing the integration of nanosilica on asphalt pavements with important scientific evidence.

Durability

The scientific literature forms near consensus: nanosilica solutions modify and enhance asphalt properties, therefore significantly increasing anti-aging performance and durability.

Life-cycle costs

Nanosilica solutions represent therefore an important technological innovation bearing the potential of reducing the life-cycle costs of asphalt roads and, now, of asphalt shingle roofs with GoNano's innovative and exclusive nanosilica solution.

A BRIEF REVIEW OF THE SCIENTIFIC LITERATURE

Nanosilica modified asphalt

Evaluation of Asphalt Binders Modified with Nanoclay and Nanosilica [1]

"During last decade, researchers' interest in nanotechnology applications, particularly in the field of pavement materials, has been increasing. (...) Finally, the Dynamic Shear Rheometer (DSR) results showed obvious improvement in the performance grade leading to higher resistance to permanent deformation."

Effect of nanosilica particles on polypropylene polymer modified asphalt mixture performance [2]

"The asphalt performance tests flexural four point beam fatigue test, indirect tensile strength, indirect tensile stiffness modulus (...) This indicates that nanosilica particles have significant effect on improving the performance properties of polymer modified binders. Also, the result reveals that thermoplastic polymer polypropylene with nanosilica particles when used as bitumen modifiers improve the performance and durability of asphalt mixtures"

The fatigue behavior of SBS/nanosilica composite modified asphalt binder and mixture [3]

"The results showed that the fatigue life of asphalt binder and asphalt mixture were increased significantly by adding SBS/nanosilica nanocomposite"

Analysis of interfacial adhesion properties of nano-silica modified asphalt mixtures using molecular dynamics simulation [4]

"The results show that oxidation aging promotes the asphaltene aggregate on the surface of the silica aggregate, while the effect of nano-silica is reversed. (...) The presence of nano-silica reduces the susceptibility of asphalt mixture to water damage or sodium chloride solution erosion."

Rheological investigation of asphalt binder modified with nanosilica [5]

"The addition of nanosilica enhanced the rutting potential of the asphalt binder. Fatigue evaluation using Linear Amplitude Sweep test showed that incorporation of nanosilica arrests the micro crack nucleation and therefore enhanced the fatigue performance of asphalt binder. (...) ."

Laboratory evaluation of composed modified asphalt binder and mixture containing nano-silica/rock asphalt/SBS [6]

"Comparing these tests results with the properties of unmodified asphalt mixture, nano-silica and rock asphalt cause an improvement in pavement performance. nano-silica/rock asphalt/SBS modified asphalt mixture had higher temperature stability, low-temperature cracking resistance, moisture susceptibility and durability than 5% SBS modified asphalt except the similar fatigue life. Furthermore, economic analysis indicated that the nano-silica/rock asphalt/SBS modified asphalt mixture had higher cost effectiveness."

Performance evaluation of nanosilica-modified asphalt binder [7]

"It was found that adding nanosilica to asphalt binder improves its rutting resistance. Results of all the rheological approaches showed that resistance to permanent deformation increases with the addition of nanosilica. Nanosilica-modified binders have high resistance to oxidative ageing."

A BRIEF REVIEW OF THE LITERATURE

Nanosilica modified asphalt

" An additional laboratory study was conducted to characterize the performance properties of the corresponding asphalt mixtures based on the resilient modulus, indirect tensile strength, fracture energy, moisture susceptibility, and fatigue life. Overall, the addition of NS material has a positive influence on different properties of the asphalt binder and mixture and can be used to construct durable pavements, thereby reduce the life-cycle costs of the pavement." [9]

"To cope with such demand, the use of nanomaterials for the asphalt binder modification seems promising, as with a small amount of modification an important enhancement of the asphalt mixture mechanical performance can be attained. Generally, the effects (...) such as, permanent deformation, stiffness modulus, fatigue resistance, indirect tensile strength, and Marshall stability. " [10]

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"(...) that the antiaging property and rutting and fatigue cracking performance of nanosilica modified asphalt binders are enhanced (...)" [8]

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Nanosilica modified asphalt

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[8] David Wingard, Ph.D., M.ASCE Research Assistant Professor, Dept. of Civil Engineering, Clemson Univ., Clemson, SC

[9] Mahmoud Enieba, Aboelkasim Diabb, Department of Civil Engineering, Assiut University, 71516, Egyp

[10] João Crucho CERIS, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

NANOSILICA MODIFIED ASPHALT

The science is clear

Nanosilica is shown throughout a decade of scientific research and testing to modify mechanical properties of asphalt, which correspond to aging factors.

By enhancing durably the different aging factors (flexibility, hydrophoby, anti-aging performance), nanosilica significantly increases overrall lifespan of asphalt.

Mechanical properties	Aging factors
Resilient modulus Indirect tensile strength Fracture energy point	→ Flexibility
Moisture susceptibility	→ Hydrophoby
Oxydation	→ Anti-aging performance

SCIENCE STUDY

Independent scientific study

GoNano conducted an independant scientific study in Canada with the CNETE on both asphalt shingles and SBS membranes.

Conclusions: with one treatment, GoNano adds 10 to 15 years of additional lifespan to an asphalt shingle roof, or an SBS membrane roof, depending on its age (roofs must be 0-12 years of age; the younger the shingles, the more lifespan generated).

National Center in Environmental Technology and Electrochemistry

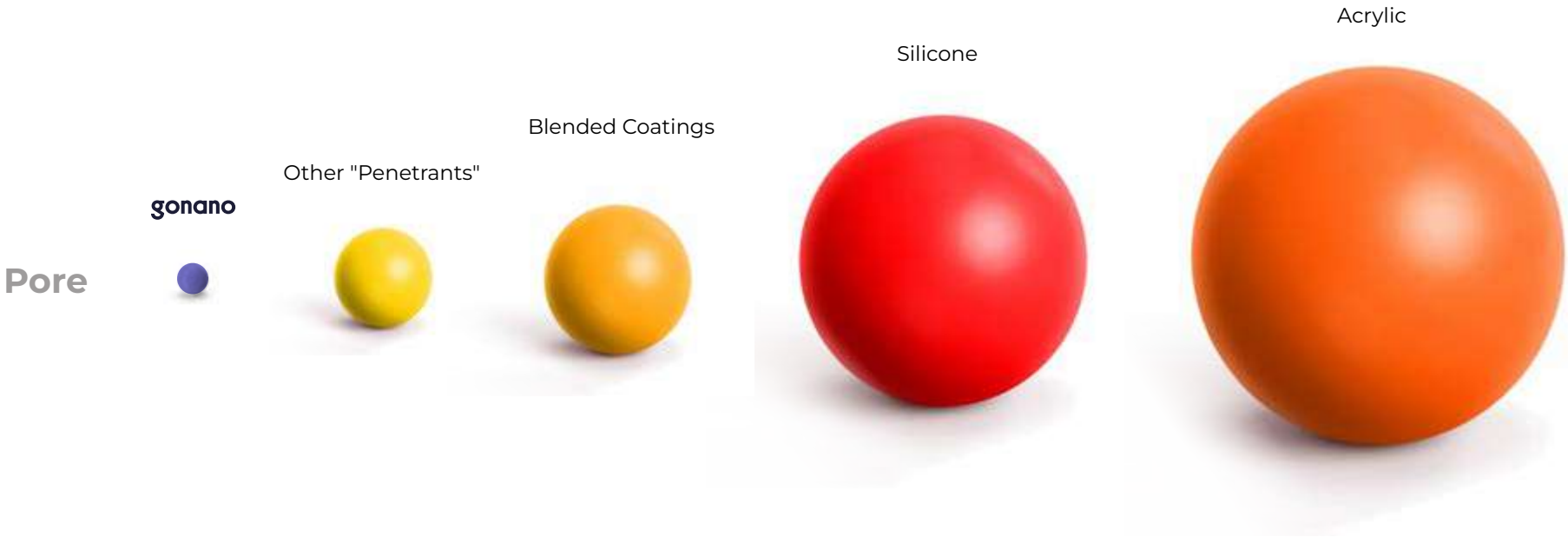
CNETE
Centre National en Électrochimie et en Technologies Environnementales

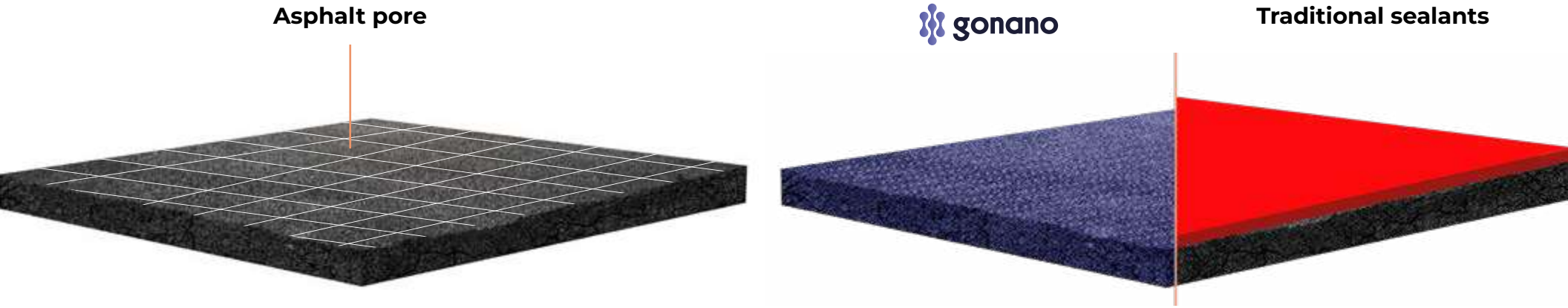
Antonio Avalos Ramirez - Ph.D., Ing.
Environmental Technology Researcher

"Asphalt shingle samples treated with the technology commercialized by GoNano demonstrated several improvements over untreated samples, including a significant improvement on anti-aging properties and durability."

GONANO PARTICLES

GoNano vs traditional sealants





GONANO EVOLUTION

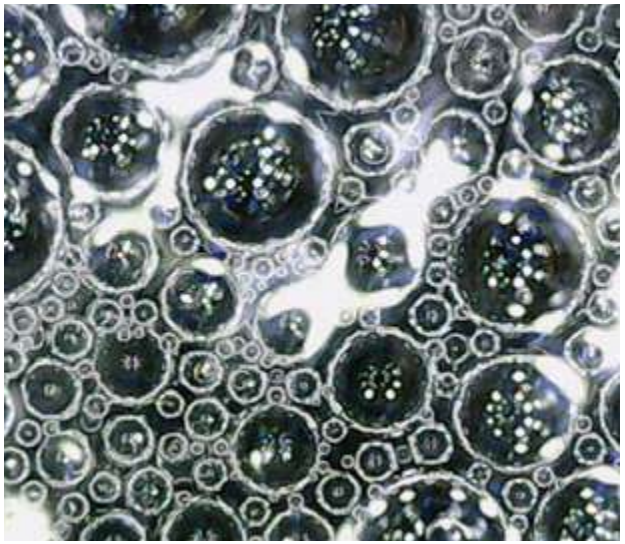
Permanent structure modification

GoNano's technology doesn't add a protective layer, like traditional sealants, nor does it simply replace lost oil: it modifies and enhances the molecular structure of asphalt shingles permenantly.

Before

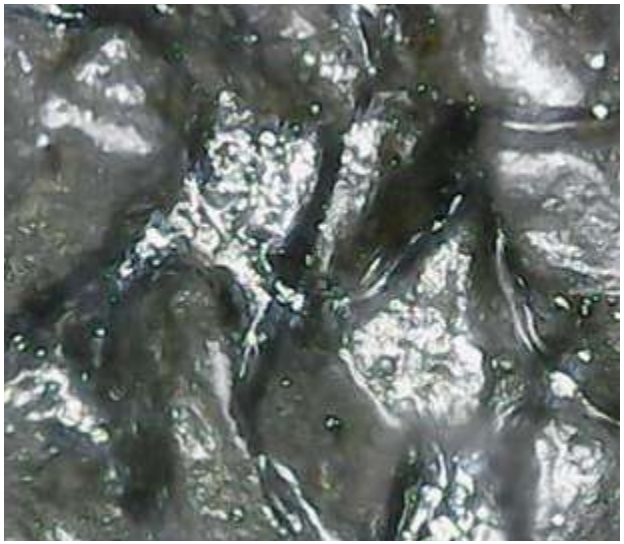
Regular shingle

During



A modification reaction takes place everywhere in the shingle

After

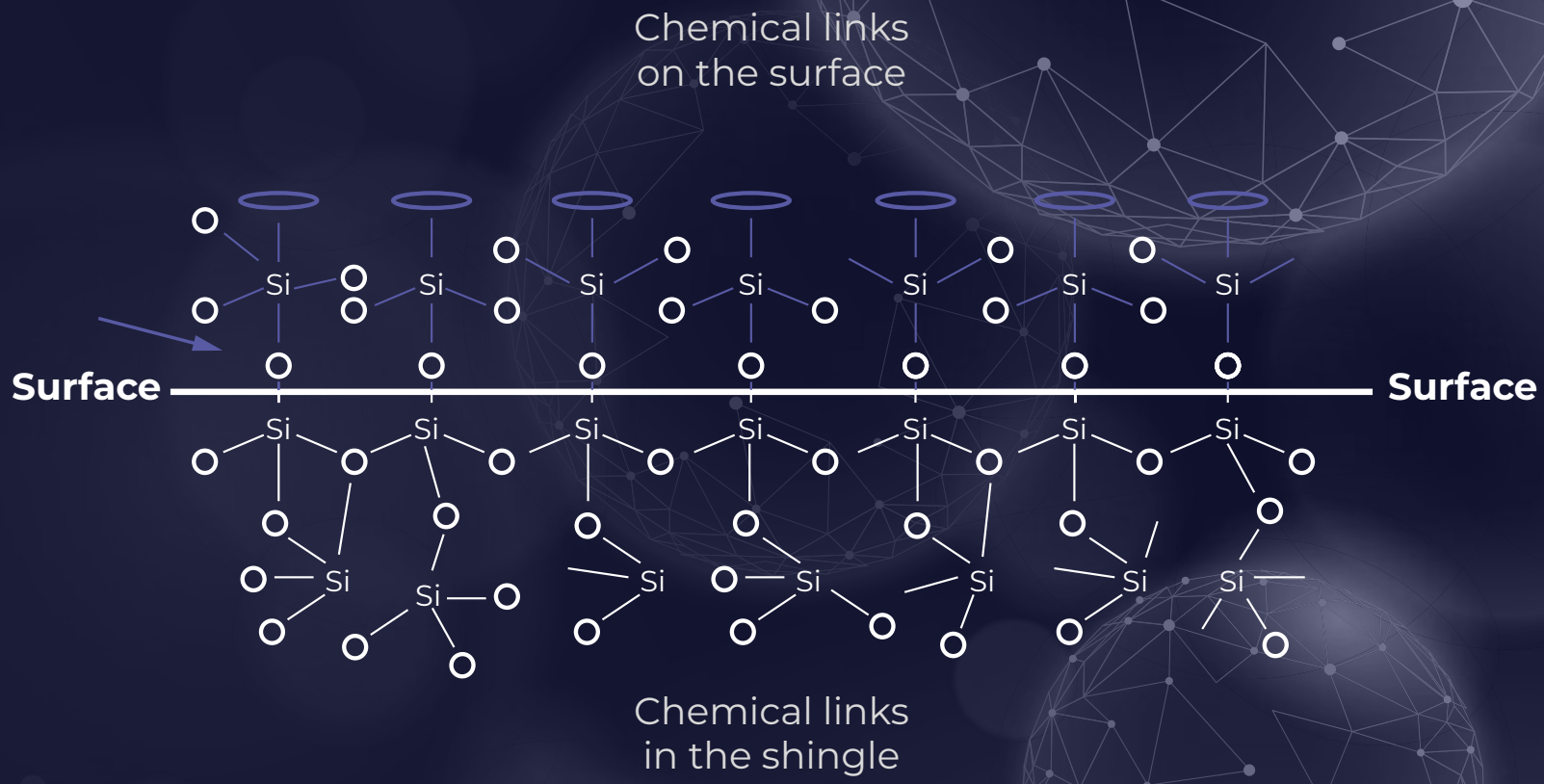


GoNano modified shingle

GONANO EFFECT

Permanent structure modification

GoNano's technology fuses at the molecular level with the organic and inorganic material of the shingle, creating new chemical bonds (SI particles) linking the different elements of the shingle together. This chemical bonding permanently changes the molecular structure of the asphalt shingle from the inside out.



GONANO IMPACTS

Technological impacts

New properties	Advantages
Flexbility	Increased resistance to hailstorms and High Winds
Hydrophobic	Cleans and prevents algae
Increased resistance to	Reduces/prevents water infiltration
Heat	Preserves and regenerates original colour
Oxydation	Stops loss of granules
UV	
Anti Moisture	More effective evacuation of ice and snow

GONANO CLASS

Class 1 Shingle vs Class 4 Shingle

Class 1

1. No impact resistance
2. High loss of granules
3. Lifespan: 12 to 15 years
4. Cost: $5-6 a S/F

Class 4

1. Highest impact resistance
2. Low loss of granules
3. Lifespan: 22-25 years
4. Cost: $9-10 a S/F

IMPACT RESISTANCE TESTING

TECHNOLOGICAL IMPACT

Hailstorm resistance

Only company

GoNano is the first and only North American company to have tested its residential roof protection technology with a major standards organization.

Official impact resistance standard

GoNano's shingle nanotechnology was tested under the official North American impact resistance standard used by standards organizations for both shingle manufacturers and insurance companies.

Conclusions of the test

#1. GoNano transforms Class 1 shingles into Class 3, with one treatment
#2. GoNano transforms Class 1 shingles into Class 4, with two treatments

Shingle Class transformation

GoNano not only adds 10 to 15 years of additional lifespan to an asphalt shingle roof, it also transforms common Class 1 roofs into the highest hail resistance Classes (3 and 4).

Durabilty

It is scientifically established that, through enhancing aging factors of asphalt durably (flexibility being one of them), the impact resistance Class transformation generated by GoNano is durable and long lasting (for the scientific evidence, see Slide 6).

A fraction of the cost

GoNano's technology represents a major technological innovation that transforms current and common Class 1 roofs into hailstorm resistant roofs (Classes 3 and 4), though only at a marginal fraction of the cost of hailstorm resistant shingles themselves (Classes 3 and 4).

Residential insurance cost reduction

GoNano reduces substantially risks of hailstorm damages, helps mitigate climate change's increasing impacts on home insurance costs, and help both homeowners and insurance companies significantly reduce one of the biggest insurance weather expenses.

Climate change

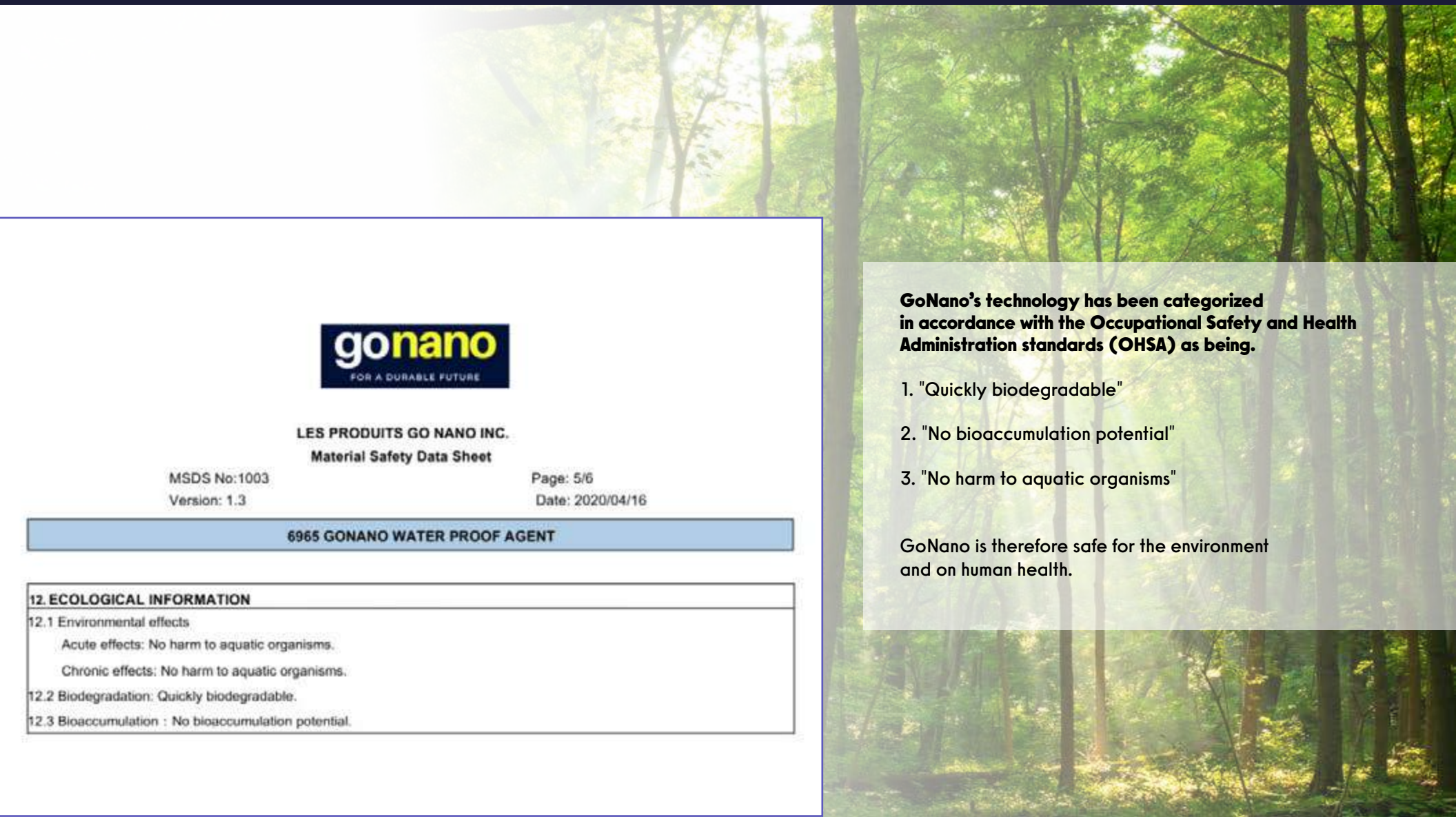
According to the Institute for Catastrophic Lost Reduction's latest report,

"Climate change will worsen future hailstorms, making impact-resistant shingles more valuable and the yellow area bigger". [1]

[1] Reference: https://www.iclr.org/wp-content/uploads/2022/04/Benefit-cost-analysis-of-Impact-resistant-asphalt-shingle-roofing2.pdf

GONANO HEALTH

Environment and human health



LES PRODUITS GO NANO INC.

Material Safety Data Sheet

MSDS No:1003 Page: 5/6

Version: 1.3 Date: 2020/04/16

6965 GONANO WATER PROOF AGENT

12. ECOLOGICAL INFORMATION

12.1 Environmental effects

Acute effects: No harm to aquatic organisms.

Chronic effects: No harm to aquatic organisms.

12.2 Biodegradation: Quickly biodegradable.

12.3 Bioaccumulation : No bioaccumulation potential.

GoNano's technology has been categorized in accordance with the Occupational Safety and Health Administration standards (OHSA) as being.

1. "Quickly biodegradable"

2. "No bioaccumulation potential"

3. "No harm to aquatic organisms"

GoNano is therefore safe for the environment and on human health.

GONANO

Conclusions

Additional lifespan

With one treatment, GoNano adds 10 to 15 years of additional lifespan to an asphalt shingle roof or an SBS membrane roof.

Shingle Class transformation

GoNano transforms common Class 1 shingle roofs to the highest hailstorm resistant shingles (Classes 3 and 4).

Insurance markets costs reduction

GoNano necessarily reduces insurance costs for the market as a whole, i.e. for homeowners and insurance companies. The only remaining question is: by how much (will be the object of a mid and long term statistical study conducted in partnership with insurance companies).

Water infiltration risks reduction

It is also expected that, through the hydrophobic property, GoNano reduces risks of water infiltration and its associated insurance costs.

The challenge of climate change

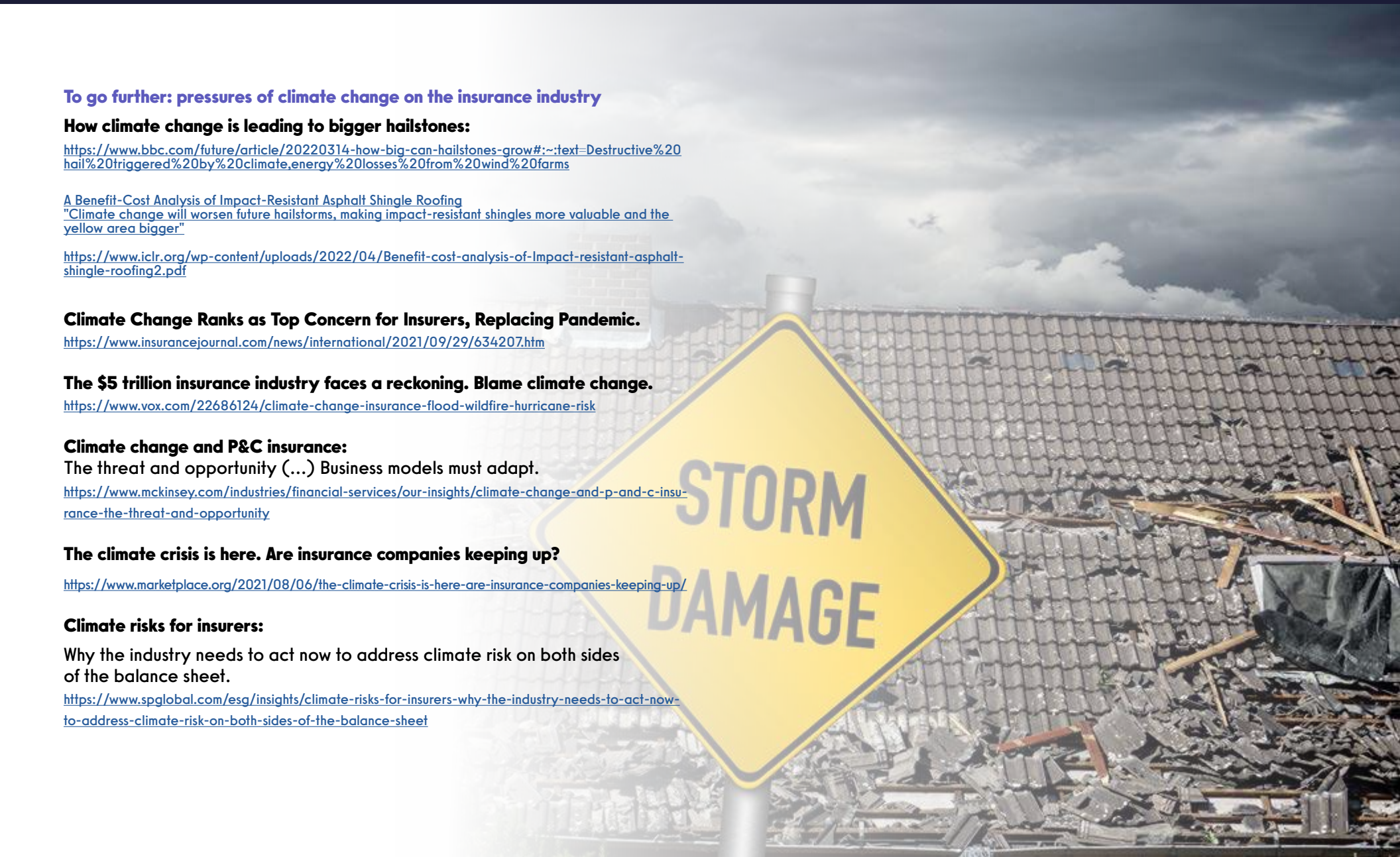
GoNano technology is a major opportunity to reduce risks of hailstorm damages, and therefore insurance costs, while helping and preparing the residential sector to mitigate the increasing destructive power of climate change.

Human health and ecology

GoNano is safe for both the environment and human health

GONANO

To go further



To go further: pressures of climate change on the insurance industry

How climate change is leading to bigger hailstones:

https://www.bbc.com/future/article/20220314-how-big-can-hailstones-grow#:~:text=Destructive%20hail%20triggered%20by%20climate,energy%20losses%20from%20wind%20farms

A Benefit-Cost Analysis of Impact-Resistant Asphalt Shingle Roofing
"Climate change will worsen future hailstorms, making impact-resistant shingles more valuable and the yellow area bigger"

https://www.iclr.org/wp-content/uploads/2022/04/Benefit-cost-analysis-of-Impact-resistant-asphalt-shingle-roofing2.pdf

Climate Change Ranks as Top Concern for Insurers, Replacing Pandemic.

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The $5 trillion insurance industry faces a reckoning. Blame climate change.

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Climate change and P&C insurance:
The threat and opportunity (...) Business models must adapt.

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Climate risks for insurers:

Why the industry needs to act now to address climate risk on both sides of the balance sheet.

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TO GO FURTHER

Pressures of climate change on the insurance industry

Insurance companies are now modifying insurance reglementation concerning homeowners' roofs.

- Stop insuring roofs older than 15 years of age
- Prorated insurance coverage for roofs older than 15 years
- Premiums increasing
- Deductibles increasing
- Insurance companies droping homeowners' insurances

Why are insurances companies reducing the insurable roof age to 15 years?

Because the actuarial assessment concludes that beyond 15 years of age, risks of damages and water infiltrations are increasing exponentially due to the limited lifespan of average asphalt shingle roofs.