Tires and nano materials

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1. Nanomaterials in tires today

2. Why a strong interest from tire industry for new nanomaterials ?

Nanomaterials in tires today

Although there are no nano particles in the factories which produce the mixtures to make tires, there are reinforcing fillers which are likely to be nano size inside the tires. They are linked in an irreversible way to rubber, and are essential for the performance of the tires.

Explanation…

Carbon Black and Silica are within scope, as Nano-structured materials

Carbon black

Obtained by incomplete combustion of a feed stock

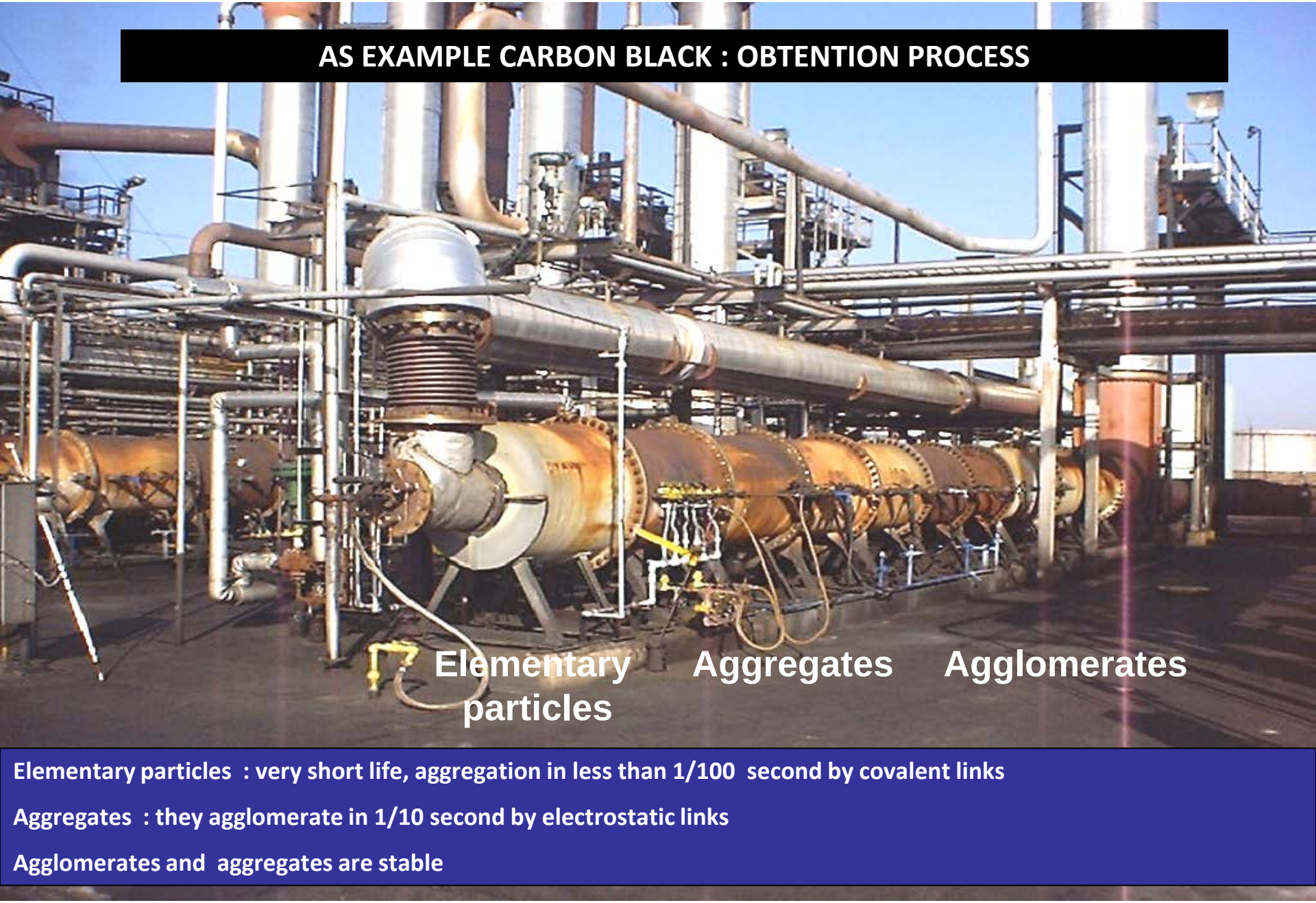
In 1910 carbon black introduced into tires increased their durability by 40 times

Amorphous silica

Obtained by precipitation of a sodium silicate solution, from melting of sand.

Silica was introduced in tire 20 years ago, decreasing rolling resistance and CO_2 emission (¼ tonne of CO_2 for each care driving 50000 km)

AS EXAMPLE CARBON BLACK : OBTENTION PROCESS



Elementary particles : very short life, aggregation in less than 1/100 second by covalent links

Aggregates : they agglomerate in 1/10 second by electrostatic links

Agglomerates and aggregates are stable

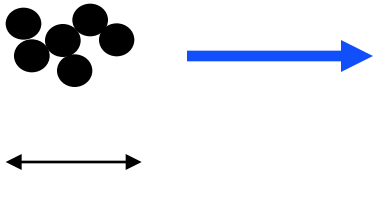
Size of particles during their production

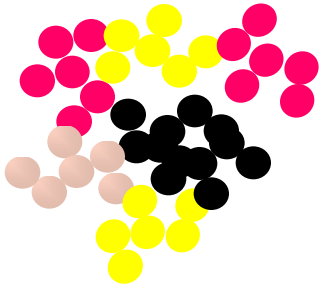
Elementary particles

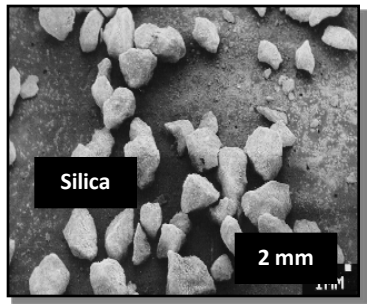
Aggregates
Covalent links between particles

Agglomerates :
Electrostatic links between aggregates

Physical aspects of industrial products







Carbon black:
20 to 110 nm
Amorphous silica :
5 to 40 nm

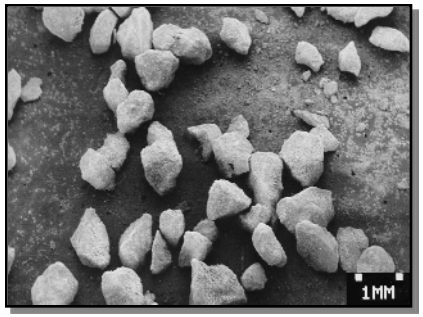
Carbon black:
100 to 500 nm
Amorphous silica :
50 to 300 nm

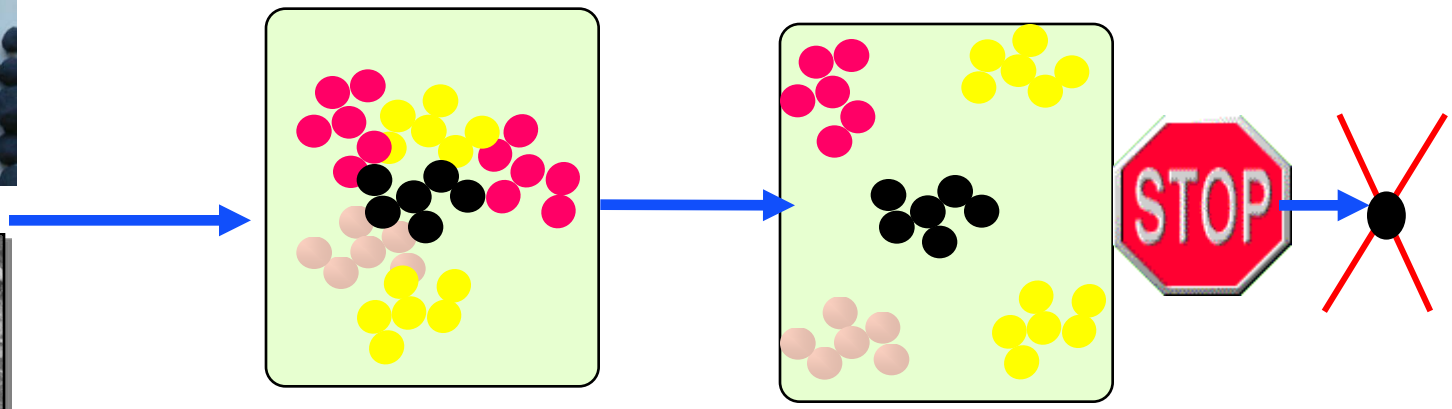
Carbone black and
Amorphous silica :
1000 to 50 000 nm

Carbone black and
Amorphous silica :
0,1 to 10 mm

Size of particles during mixing with rubber

granules are introduced in internal mixer to be incorporated in rubber
Very strong energy -> destruction of granules and of mains agglomerates.
No possibilitiy to destroy aggregates





Granules or pearls
Carbon black ana
amorphous silica :
0,1 to 10 mm

Agglomerates
Carbon black or
amorphous silica :
1000 to 50 000nm

Carbon black :
100 to 500 nm
Amorphous silica :
50 to 300 nm

In summary, today

Today, nano particles are not directly used in factories producing tires.

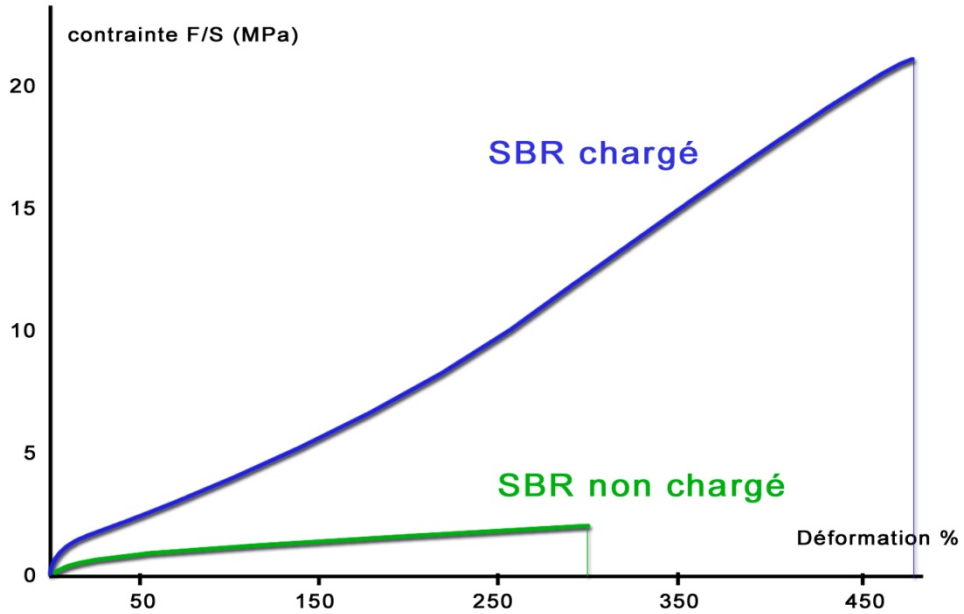
But … carbon black and amorphous silica aggregates, at nano-sized particles, are generated inside the rubber during the mixing and are chemically linked to the rubber by covalent links.

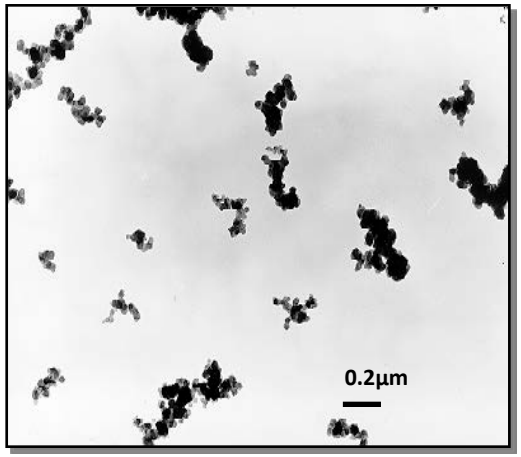
Carbon black and amorphous silica are giving reinforcement because they are chemically linked to rubber molecules

Strong improvement of tire performances

Tensile strength increases

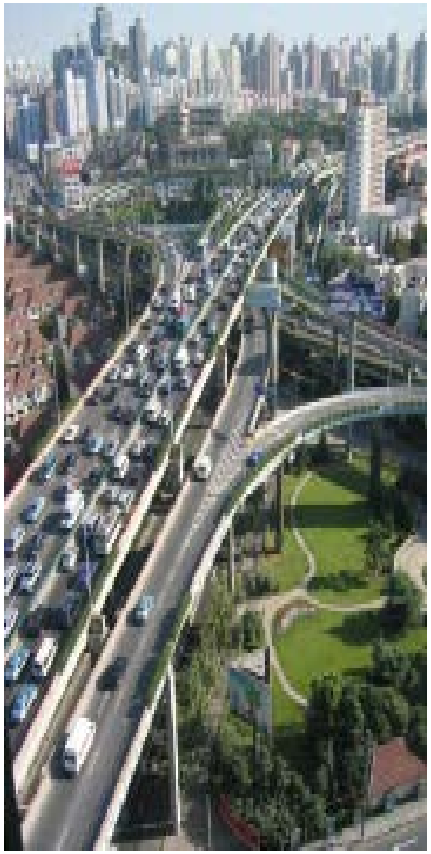
Elongation at brake increases





There is no reinforcement if agglomerates and aggregates are not linked with rubber macromolecules by covalent links.

Why a strong interest from tire industry for new nanomaterials ?



In 1950 there were 50 million vehicles on earth

In 2009 : There are 800 million vehicles

In 2030 : expert estimation gives 1,6 billion vehicles, with growth mainly in emergent countries

Today the sector of the road transportation is the origin of 18% of the emission of fossil CO_2….

… and, because of the rolling resistance, the tires contribute 20% to the consumption of fuel of a car (or 30% in the case of a truck).

Worldwide production of tires : 1,11 billion in 2008.

To double this production, without new technology , => need of two times more raw materials - this is not possible.

Goals of TIP

- To divide by **two** the rolling resistance of the tires, to not generate one gram of additional CO2 in spite of the increase in the number of tires

- To divide by **two** the speed of tire wear and to reduce the tires' weight so as not consume a gram of additional raw materials.

- Development of new nanomaterials is one of the most promising research avenues.

- **There is an agreement between the eleven main producers of tires : *no development of nano materials which may generate a health hazard for human or for the environment*.**

Scope of economic impacts of nanomaterials in tires

Some of the economic impacts will be felt by the consumer, others by the industry, and others at a more macro level (eg impact on total carbon emissions and the global prices for raw materials) – in a global transport environment where the number of vehicles will double by 2030.

- **Reduced CO_2 output per tire (and per vehicle) [due to decreased rolling resistance]**
- **Frequency of tyre purchase reduced by at least half (double life of each tire)**
- **Reduced pressure on limited natural resources (rubber and others)**
- **Increased use of new materials**
- **Greening of growth in tyre production in a sustainable way**

- In 2005, CEOs from 11 largest Tire Companies took the decision to join their efforts for improvement of sustainable development in the tire industry (addressing - Tire wear particles ("TWP"), Tire materials, Scrap tires …)
- **Tire Industry Project** launched in 2006 and organized as a sector project at the ***World Business Council on Sustainable Development*** (WBCSD)
- In 2010 the CEOs concluded that development of new nanomaterials is a promising way for sustainable development. But they won't make any development which may present a risk for the human health or for the environment.

- TIP is in a collaboration under the lead of the OECD to examine sustainable development and use of nanomaterials by the tire industry
  - A case study on societal advantages if tire industry develops and uses advanced nanomaterials
  - A guide on best practice for development and use of new nanomaterials in tires, taking in account all life cycle of tires
  - OECD report due October 2013

Thank you