CHEMISTRY CHANGES EVERYTHING

CONDOMS OVER THE CENTURIES

Original article by Dr Tony Ryan, by permission from
The Royal Society of Chemistry

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Original article in English

CITIES (*Chemistry and Industry for Teachers in European Schools*) is a COMENIUS project that produces educational materials to help teachers to make their chemistry lessons more appealing by seeing the subject in the context of the chemical industry and their daily lives.

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- Czech Chemical Society, Prague, Czech Republic , http://www.csch.cz/
- Jagiellonian University, Kraków, Poland, http://www.chemia.uj.edu.pl/index_en.html
- Hochschule Fresenius, Idstein, Germany, http://www.fh-fresenius.de
- European Chemical Employers Group (ECEG), Brussels, Belgium, http://www.eceg.org
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Condoms over the Centuries

From the ancient to the modern

- History
- Materials
- Benefits
- Manufacturing
- Future

Where and when did all this begin?

Ancient Egypt

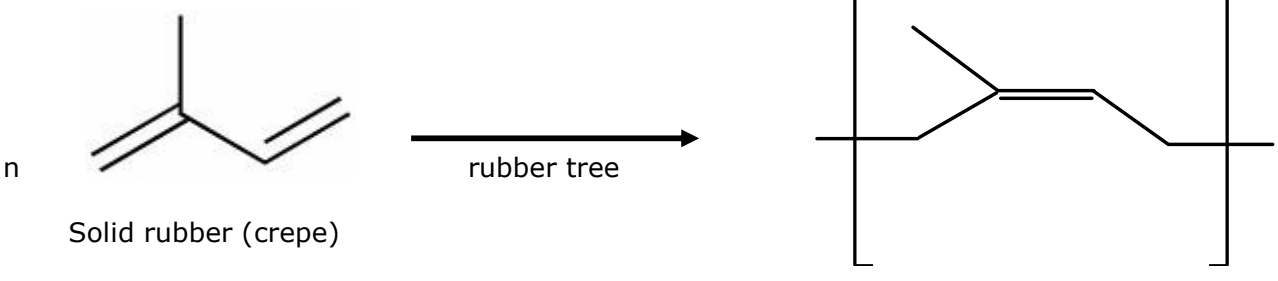
- The oldest form of artificial contraception
- In use up to 6000 years ago
- A linen sheath used in Egypt to protect against syphilis
- First record of European use on cave painting at Combarelles (France) - 1st century AD
- Possibly named after a member of the court of King Charles II — more likely to be derived from the latin word *CONDUS*, meaning receptacle
- By 18th/19th centuries, condoms were widely available, usually made from animal gut

Is this really chemistry? Where is the chemistry in it?

The use of animal gut was unreliable and was much improved by the introduction of vulcanized crepe rubber. Vulcanizing was patented by Thomas Hancock in late 1843 and Charles Goodyear a few months later.

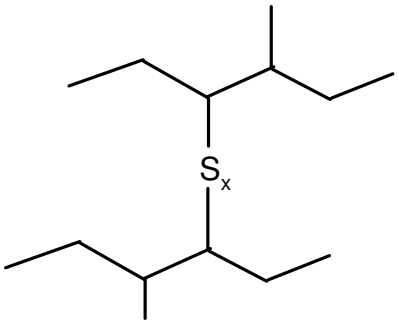
This material was used until the introduction of liquid latex in the early 1930s.

Vulcanised crepe



Solid rubber (crepe)

Cis-polyisoprene



two adjacent Cis-polyisoprene chains, crosslinked with one (or more) atom(s) of sulfur

The Latex Revolution

For almost 90 years, the vulcanized crepe rubber condom reigned supreme. However, in the early 1930s this revolutionary technique was superseded by the introduction of liquid latex.

The process of dipping formers into the latex became the standard method of manufacture and is still the basis for the production of condoms today.

Natural Rubber Latex

Natural rubber latex (NRL) is a milky fluid derived from the Hevea Brasiliensis tree. It is a dispersion of rubber particles in water stabilised by protein surfactants

(photographs from Google Images)

Why natural latex?

Natural rubber latex is used to manufacture condoms because it has very good physical properties.

It is a naturally available, renewable resource.

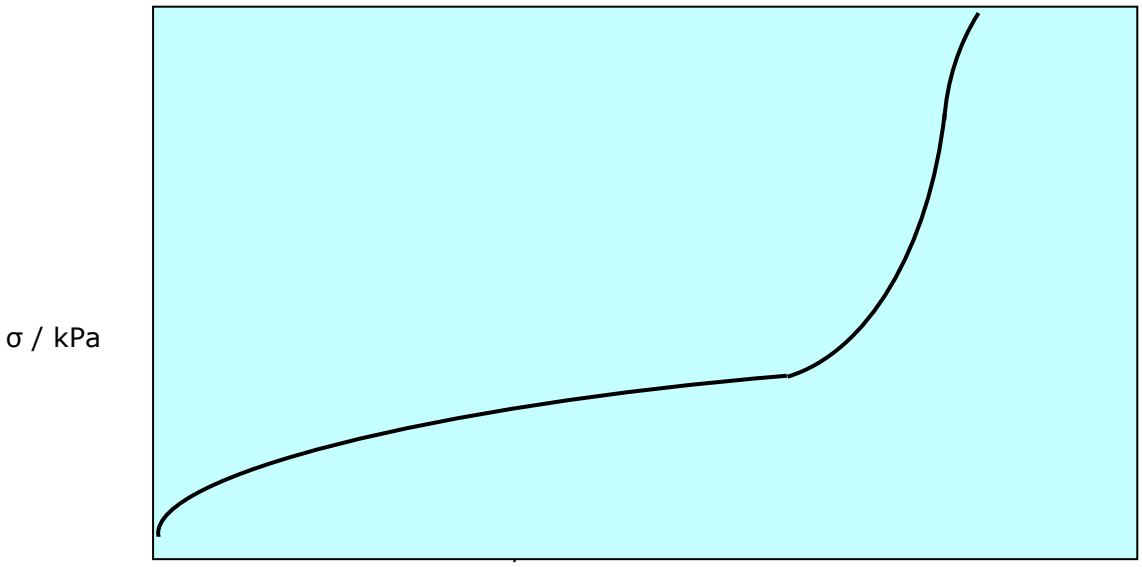
(photograph from Google Images)

Materials selection

- Competing materials properties
- Low modulus ("soft") ~ 1 MPa
- High elongation > 300%
- High strength ~ 10 MPa
- Film formation (typically 100 - 500 μm)
- Burst resistance Membrane thickness is defined by the specification for bursting pressure i.e. thick enough film to hold 2 litres of water, for ultrathin

Natural Latex Rubber Properties

- $G = \rho RT/M_c$
- Elongation at break > 1000%



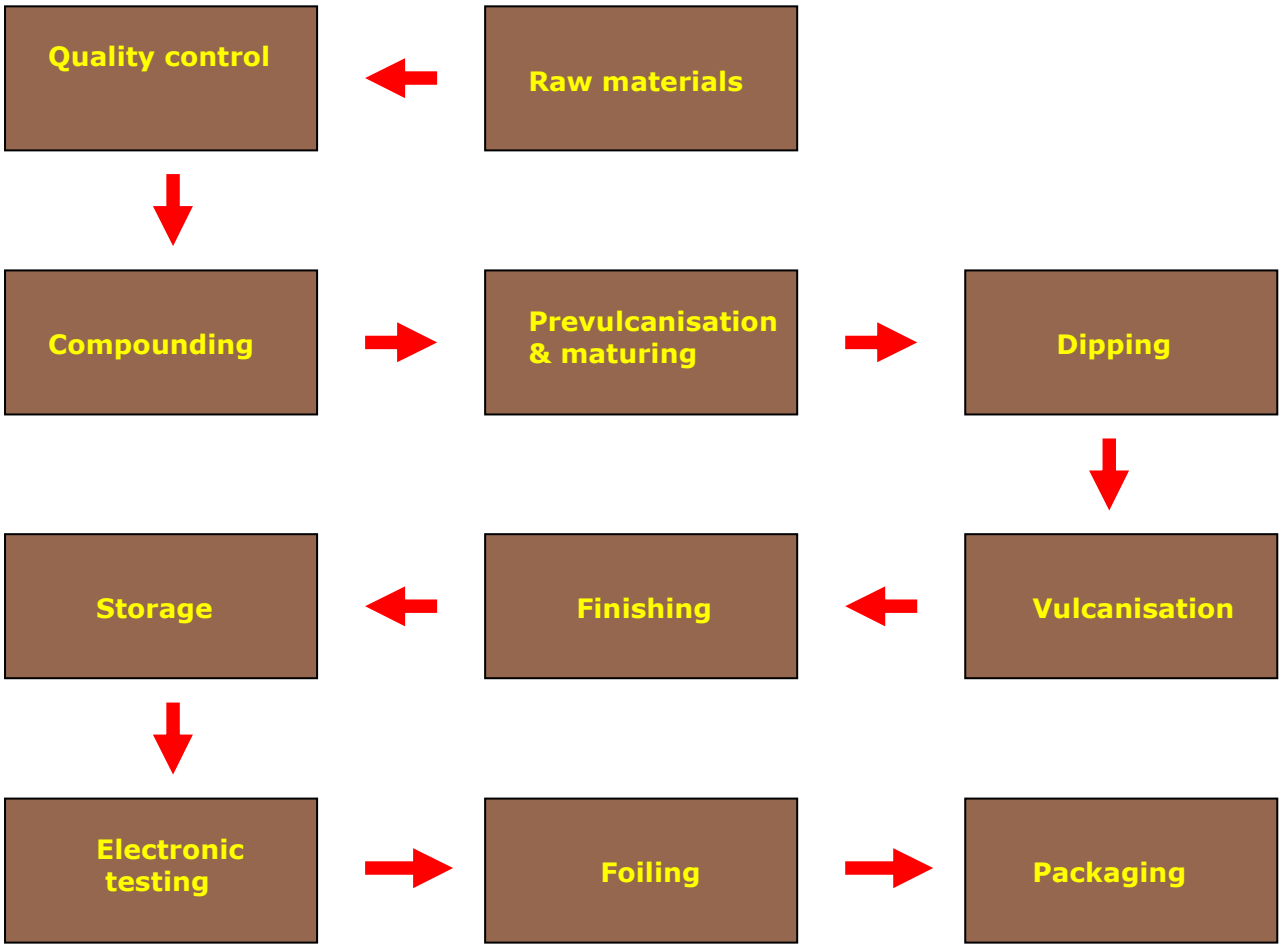
So you want to try something out?

- Take a condom and fill it with water. See how much it stretches under the weight of the water it contains.
- Try to inflate a condom by blowing into it. European Standards require that a condom should be able to expand to a volume of 18 litres before bursting. Some will expand up to 40 litres in reality!

In 1929 the DUREX trademark became the generic name for condoms

- **DU**rability
- **R**eliability
- **EX**cellence

Condom manufacturing process



Compounding

- To give the latex stability and strength, crosslinker and acclerator are added and the latex is heated ("prevulcanised"). These react with the rubber in the latex to form cross-links and leave nascent reactivity.
- Proprietary formulations are the result of research and development and ensures condoms are strong, reliable and have a low allergenic potential.

Maturing

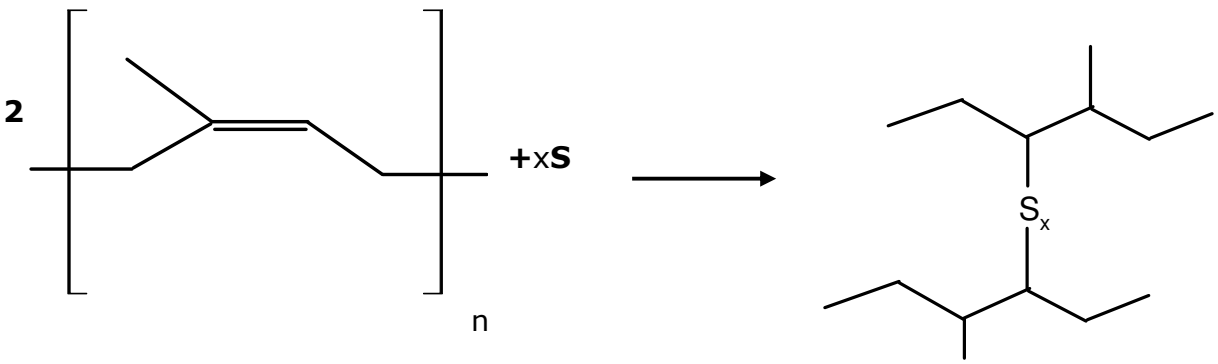
- The latex compound now undergoes a maturation process prior to being used.
- At the end of the maturation process, the latex is tested (film formation, mechanical property specification) to confirm it is suitable for making condoms.

Dipping

- After maturation, the latex is transferred into temperature-controlled reservoirs in the production area which are enclosed to minimise the presence of dust particles
- A continuous line of clean glass formers are dipped into the latex, where they become coated. The formers are rotated to ensure the latex is distributed evenly.
- After drying, the formers are dipped for a second time to increase the thickness of the latex

Condom Vulcanization

The formers pass through an oven to vulcanize the rubber - this completes the chemical reactions (with the crosslinking agent) and ensures that the condoms have the necessary strength and elasticity. The chemistry involved at this stage was listed earlier.



Powdering

- The condoms are removed from the formers, washed to remove any water-soluble impurities and powdered using pharmacologically safe materials – for example magnesium carbonate or calcium carbonate.

- Why? – to prevent the condoms from sticking to each other.

Storage

The condoms are now stored for up to 21 days to mature. This allows the material properties to stabilise before the condom progresses through to the next stages of the manufacturing process.

Testing

- To ensure condoms are of the highest quality, samples from each batch undergo stringent testing procedures at all stages of the manufacturing process.
- Such tests include:
  – visual inspection for defects
  – water testing to check for holes
  – measurement of tensile strength
  – air inflation to check for burst strength
  – measurement of thickness and length

Electronic Testing

- Every condom made by Durex undergoes electronic testing (ET) to check for holes and imperfections. A high voltage is applied to the film, and any passage of electrical current leads to the condom being rejected.

- A sample of condoms after ET is checked. If the condoms fail on any of the tests the whole batch is discarded.

Foiling

- The condoms are automatically rolled off the ET, and are transferred to a machine which inserts them into the single-unit pack – the "foil".
- Lubricant and flavouring (where used) are injected into the foil at the same time.
- The foils are heat-sealed and stamped with a batch number and expiry date. A sample of the foils is tested for leakage and other defects.

Packaging

- The foiled Durex condoms are packed into their boxes, ready for dispatch to the customer.
- However, a final round of testing to relevant National and International Standards is carried out before the condoms are released

Quality Control

- Prior to purchase, each batch is tested and certified at the plantation
- On arrival at the factory, the batch is again tested against the certification and is given a unique code which it carries throughout the production process
- Quality assurance tests are carried out at all stages of the manufacturing process.

So what are the benefits?

Prevention against pregnancy
Protection against sexually transmitted diseases, e.g. gonorrhoea, syphilis, Chlamydia, HIV/AIDS
Widespread availability
Relatively inexpensive
Produced from a sustainable resource

Are there any known risks?

Hypoallergenic reaction.
Slippage/bursting

Possible developments on the horizon?

New materials, lubricants, flavours, shapes and accessories
Biodegradable construction?
Development of polyurethane/nitrile materials as alternatives for persons with latex allergies.

Intrigued by what you have read—and want to find out more?

Go to www.durex.com
There are numerous other websites giving details of condom history and manufacture. Simply search under "condom history".