Stories of Science: From Silly Putty to G-Putty?

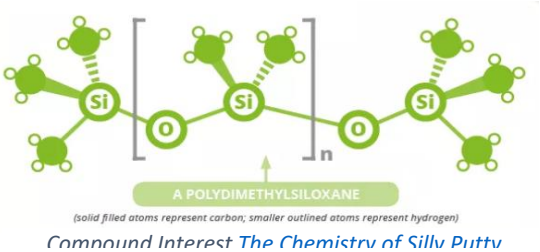
The story about tells the story of an accidental discovery with an exciting future.

One of the most important resources needed during world war II was rubber. It was essential for truck tyres, soldier's boots, gas masks, life rafts, and even bombers. Early in the war, the Japanese attacked many of the rubber-producing countries in Asia, drastically affecting the supply route. Governments were forced to place rations on petrol and propaganda posters instructed people how to care for their household rubber products so they would last the duration of the war.

An accidental discovery in the race for synthetic rubber

During 1943 engineer James Wright was attempting to invent synthetic rubber but discovered a material with different, but unusual properties. In a test tube, Wright had combined boric acid and silicone oil, producing an interesting gob of goo. Wright conducted a multitude of tests on the substance and discovered the non-toxic putty would bounce when dropped, could stretch farther than regular rubber, would not go mouldy, and had a very high melting temperature. At the same time Earl Warrick also made the same discovery and was paid $1 for his patent. Unfortunately, though it was a fascinating substance, it didn't contain the properties needed to replace rubber. Neither Wright nor Warrick saw a value in the polymer they had created, and the US government had little interest in it.

Marketing consultant Peter Hodgson did however see a use for the new substance and a business opportunity, and despite being $12,000 in debt, Hodgson borrowed $147 to buy a large quantity of the putty which he named "Silly Putty, The Real Solid Liquid." It was first sold to adults as a stress relief toy but he soon repackaged in plastic eggs for children at Easter. Silly Putty sold faster than any other toy in history, registering over $6 million in sales in the first year. Since 1950, more than 300 million eggs of Silly Putty have been sold, including glow-in-the-dark and metallic, iridescent and magnetic versions.



Compound Interest The Chemistry of Silly Putty

A polymer is a very long molecule made of repeating monomer units. The main polymer in Silly Putty is called polydimethylsiloxane. The boric acid helps to create crosslinks between adjacent polymer chains. Silly Putty has viscoelastic properties. In other words, over long times or at high temperatures, Silly Putty behaves like a highly viscous fluid but over short times or at low temperatures it behaves like an elastic solid. When the molecular weight of polymer is high, the chains can also get tangled adding to these properties.

From child's toy to serious science

The possibilities of the applications in science of silly putty were clear when it went to space with the Apollo 8 crew in 1968, where it proved effective at keeping objects in place in zero gravity. The material's unique properties have found niche uses in a range of medical and scientific applications such as the rehabilitative therapy of hand injuries. A modification of silly putty has been to turn it into G-putty. Graphene is the thinnest, strongest material known to exist and is also extremely flexible (see Science Story on Graphene for more information). It's made of a single layer of bonded carbon atoms and conducts electricity remarkably efficiently. Tiny sheets of graphene only a nanometer (10^{-9}m) thick were added to Silly Putty making a microscopic network of electrical conductors. When the composite material is squashed, stretched or deformed the electrical resistance of the material changes. G-putty can act therefore as an acutely sensitive pressure sensor. G-putty is sensitive enough to sense a spider scurry across it or more usefully measure how much pressure blood exerts on the artery walls when the heart beats or rests.

Silly putty shows how a serendipitous discovery of a new material can find a use in children's toys and be combined with later discoveries to make a futuristic material that may find applications in medical technology.

Comprehension and Reflection Questions

1. Why would the US Government put a ration on petrol if they were trying to save restrict the use of rubber?

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2.What is a polymer?

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3.a) What is a crosslink?
b) How does is affect the properties of a polymer.
c) Suggest the bonding formed in a crosslink.

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4. Can you give examples of natural and synthetic polymers?

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5.a) What does viscous mean?
b) Can you explain how increasing chain length affects viscosity.

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6.a) How big is a nanometer in scientific notation?
b) If there was a layer of G-Putty 0.4cm high how many nanometers is this?

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7. Describe the structure of graphene explaining why it is such a good conductor of electricity and flexible

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Extension Activities

Ideas for things to do next:

Synthetic Rubber was eventually created using products from crude oil.
Suggest and evaluate a Life Cycle Assessment of using Synthetic rubber for car tyres.

This story touches on a lot of science across Chemistry. Can you create a mind-map weaving together the key ideas? Think about structure and bonding, polymers, organic chemistry and using resources.

As an extension, can you include some key ideas from physics that tie this story together? Particle model, forces, energy and electricity.

Further Reading

Ideas for things to read next:

https://www.youtube.com/watch?v=L7M8Ar5FIwE

Silly-putty-can-detect-spider-footsteps

Compound Interest – The Chemistry of Silly Putty

https://www.sciencedaily.com/terms/polymer.htm