# 1,3-Butadiene

Golf balls, tyres and Lego

## What have golf balls, tyres and Lego got to do with anything?

They are all made from polymers, from which the main starting material is butadiene.

## Butadiene – that’s an odd name?

Not really – it’s quite logical. The ‘buta’ part is from butane, meaning 4 carbons. The ‘ene’ suffix means that it contains double-bonded carbons (*i.e*. it’s an alkene), and the ‘di’ means it has two of them.

## And the 1,3?

That tells you where the double-bonds are. If you start at one end of the molecule and number the carbon atoms from 1 to 4, the prefix ‘1,3-‘ means that there’s a double-bond starting at carbon-1 (*i.e*. between C1 and C2), and another starting at carbon-3 (*i.e*. between C3 and C4). There is also an isomer of butadiene called 1,2-butadiene, but because this has the two double bonds next to each other (a ‘cumulated’ diene) it’s very unstable and so not much use.



1,3-butadiene 1,2-butadiene

## What’s it used for?

Because of its double bonds, butadiene can be polymerised into long chains. The Russian chemist Sergei Lebedev was the first person to do this in 1910, making was one of the first synthetic rubbers

## Why make synthetic rubber when you can extract natural rubber from trees?

Two reasons really. If you can synthesise rubber you can change the ingredients and therefore the properties of the rubber to suit different applications. Also, not every country has access to rubber trees. This became particularly important in the middle of the 20th Century, when the various world powers were squaring up for battle in what would eventually become WW2. The British Empire had access to rubber trees in India, while France had them its South East Asia colonies. But Germany had no colonies with rubber trees, nor did Russia, nor did Japan. Nor did the USA, except via its association with the UK and India. And since rubber is an essential component for tyres in most motorised vehicles, wars might be won or lost on whether an army had enough rubber. So an alternative to natural rubber was urgently sought after by every industrialised country in the world.



# Sergei Vasilyevich Lebedev

## And Lebedev found it?

Yes, in 1928, he developed an industrial method for producing synthetic rubber based on polymerisation of butadiene using metallic sodium as a catalyst, and this was quickly adopted by the Soviets into an industrial process. The butadiene monomer was synthesised from ethanol that the Russians distilled from grain or potatoes, which led to a number of jokes about Russian tyres being made from potatoes! By the time WW2 started the Soviet Union had the largest synthetic rubber industry in the world, and the method had been copied by the Germans, Japanese and Americans allowing those countries, too, to engage in the war.

## Are all tyres made from polymerised butadiene?

About 70% of the world’s production of over 2 million tons of polybutadiene per year goes towards making tyres. However, pure polybutadiene is too elastic for most tyres, which need to be harder and more wear resistant. The properties of butadiene can be altered by using different catalysts to change the way it polymerises. The polymer with trans double bonds forms straight rigid rods, which allows the polymer o









styrene



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