

## History of polymers:

Naturally occurring plastic materials can be found in the forms of animal bones, horns, tortoise shells, the fossilised resin from pine trees (amber), the albumen in egg, the sap from various tropical trees, and the wax from bees, and many of these natural polymers are still in use today. Casein, derived from milk, is still used to manufacture buttons. Bitumen is still used in surfacing roads and shellac, which was used for early gramophone records, is still used in the production of wood varnish. Shellac, which is produced by the lac beetle, was used by early Chinese cultures as a varnish and as such is still in use. In the nineteenth century it was mixed with fillers and moulded into brush backs, mirrors and picture frames.



*Figure: A shellac picture frame, known as a union case, made about 1860.*

Papier mache, which because of its mouldable properties can be considered a plastic, was patented in 1772. Gutta Percha, which, like latex, is extracted from tropical trees, was used to make a wide range of household items and also to insulate the first submarine telegraph cable between Dover and Calais. It is still used in the manufacture of some types of golf balls.

In 1838 Charles Goodyear heated latex rubber with sulphur to make a durable and elastic material. He found that the more sulphur that he added the harder the material became and he termed his new invention 'vulcanite'. This was the first time that a natural polymer had been deliberately modified and so was the first of the semi synthetic materials. One of the uses found for it

was to make match stick holders. It is still used today, moulded into pipe stems, and mouthpieces for musical instruments.



*Figure: A vulcanite matchbox, known as a vesta case, made about 1880.*

Bois Durci, which is made of cellulose in the form of finely ground wood blended with albumen from cows' blood, was patented in France in 1855. It was compression moulded in a heated mould and often used to make ornate plaques that were inlaid into furniture.

In the nineteenth century manufacturing meant huge increases in the mass production of goods. A rapid increase in population, a general improvement in the standard of living and the growth of towns and cities brought with them an increased desire for material goods, especially as status objects. As traditional crafts were superseded by mechanisation (making things by machines instead of by hand) and the volume of production increased, new materials were needed to replace expensive natural materials like horn and ivory.

In 1862 a material called Parkesine was exhibited at the Great International Exhibition in London. It caused a lot of interest as a plastic material that could be used to make high quality products. It could be repetitiously moulded, in colours, and with a finely detailed surface. Its inventor, Alexander Parkes, had made it by dissolving cellulose in the forms of wood flour and cotton waste in nitric acid, thereby making cellulose nitrate. In 1866 Parkes set up a manufacturing company, but he could not control the quality of the product due to its brittleness and was forced into bankruptcy.

Cellulose nitrate was first adopted commercially in America in 1869 where the Hyatt brothers made a much more mouldable version of it by mixing the cellulose nitrate with camphor. Cellulose nitrate was given the trade name of 'celluloid' and as ivory was in short supply at the time one of its first uses was the manufacture of billiard balls. However it was soon discovered that celluloid made from cellulose nitrate was explosive, and when you banged the billiard balls together they sometimes blew up! Celluloid made from cellulose acetate was developed to overcome this problem, and this is still used today in the manufacture of table tennis balls. Very large quantities of celluloid products were made for the American and European markets and the material became the first of the mass-produced plastics.



*Figure: A celluloid dressing table set made about 1910*

In 1907 a Belgium chemist living in America called Leo Baekeland, developed the first truly synthetic plastic called phenol formaldehyde, much better known under the trade name of 'Bakelite'. Bakelite was used initially in electrical goods but soon began to appear in other consumer products. Since it was brittle it was strengthened by adding wood dust to it, which is why much early Bakelite is brown in colour. This process of adding other materials to plastics, (called fillers), to give them strength is an important part of plastics technology today. Bakelite was an enormously popular material for domestic products as it was relatively cheap and easy to manufacture and gave a consistently high quality product. Many Bakelite products were made that still survive today.



*Figure: A bakelite thermos flask.*

The early developments in polymer technology occurred without any real knowledge of the molecular theory of polymers. The idea that the structure of polymers in nature might give an understanding of plastics was put forward by Emil Fischer, who in 1901 discovered that natural polymers were built up of linked chains of molecules. It was not until 1922 that the chemist Herman Staudinger, proposed that not only were these chains far longer than first thought, but they were composed of giant molecules containing more than a thousand atoms. He christened them 'macromolecules', but his theory was not proved until 1938 when the first plastic was created with a predictable form. This was the first synthetic fibre, nylon.

As metal replaced wood in many consumer products, plastics were developed as an even cheaper alternative. The cost of casting metal increased sharply after World War II, while plastic could be formed relatively cheaply. For this reason plastics gradually replaced many things that were originally made in metal, particularly casings for products. In the 1930s, Bakelite's easily mouldable properties were ideal for designers looking for new materials for cheap domestic products. They wanted a material that could be mass-produced cheaply, yet still produce stylish products. Now luxury items such as jewellery, which had previously been made from ivory, could reach the mass market made of celluloid.