Latex, Rubber, Balata, and Chiclé
Rubber, gutta and chiclé - Outline

Importance
  o Natural rubber versus synthetic materials

Botanical
  o *Hevea brasiliensis*

Properties

Economics
  o Disease situation
  o Limited gene base of cultivated types
Isolation and processing

Gutta percha

Chiclé
Reading

• CHAPTER 10, 253 ff.
Introduction

• Most latex plants come from the New World.
• Latex is a mixture of compounds borne in special structures called laticifers.
• The composition differs in different species, but typically contains water, terpenes, sugars, enzymes, etc.
• In many plants latex has a milky appearance, but not in others. (Latex in latex paint is a synthetic material and is not related to true latex).
• The properties of latex were apparently discovered by different groups of people in different areas.

• The Aztecs of Mexico played ball with balls made of latex of *Castilla elastica* (Moraceae).

• In the Amazon area, the Indians waterproofed clothing by coating it with latex of *Hevea brasiliensis* (Euphorbiaceae). The Spanish in South America also began to use it to waterproof clothing.
Castilla elastica, Moraceae
• In 1770, the famous chemist Priestley discovered that rubber could be used for removing pencil marks.
• In 1823, Charles Macintosh discovered that rubber was soluble in hexane. Further, when the solution was applied to clothing, a thin layer was left on the clothes.
• He invented the "Macintosh" (a raincoat -- not a computer).
• In cold weather, they cracked.
• In hot weather, two people with Macintoshes often became inseparable. Their coats stuck together.
• In 1839, Charles Goodyear (whose wife allegedly nagged him) while working in his garage (that's why he worked in the garage) discovered how to vulcanize rubber and make it non-sticky and much more usable.

• In this process, because of added sulfur, the rubber becomes cross linked and also has better elasticity.
Whenever people tried to raise rubber trees in South America, the plants were attacked by a fungal disease.

In 1876, Sir Henry Wickham took seeds of rubber trees from Brazil to the Royal Botanical Gardens in Kew, near London.

Seedlings were taken from there to Singapore and then to other places in Southeast Asia.

Luckily, the fungal disease was not taken along with the plants.
• Rubber was extracted mostly from wild trees of *Hevea brasiliensis* until the 1890's.
• The latex was collected (often in leaves) by slashing the trees diagonally.
• The latex is about 30% rubber and the rest is serum.
• When the latex was collected, it was filtered, mixed with water and slowly poured over a paddle held over a smoky fire.

• A ball of coagulated latex was eventually prepared.

• Rubber is still prepared in Brazil in this manner.
Rubber tapping in Brazil
Smoking latex in Brazil about 1915
Shipping rubber in Brazil – about 1915
• In Asia, cultivation of the plant is much more carefully done.
• The plant is grown on extensive plantations.
• Numerous breeding programs are in progress.
• The "jebong" method of tapping the trees gives better yields and is less harmful to the trees.
Latex from *Hevea brasiliensis*
Jebong method of tapping
Collecting latex in Malaysia about 1947
• Today, however, dilute acetic or formic acid is added to coagulate the rubber (especially in Asia) and the rubber rolled into sheets.
Coagulating latex
Rolling coagulated latex into sheet
Pressing water from coagulated sheet of latex
Drying latex sheets
Drying latex sheets in India

Courtesy Dr. Dorothea Bedegian
• As rubber began to be used in pneumatic tires, about 1900, there was a rubber boom.
• In 1910, rubber sold for $3.10 per pound.
• Towns, such as Manaus in Brazil, did well economically. They even had an opera house and European opera companies came there (many of them got malaria and died).
• But at that time, the production of rubber plantations in Southeast Asia became important and the price went down.

• In the 1920s rubber went to 14 cents per pound and in 1932, it sold for 3 cents per pound.

• By World War II, 90% of all rubber came from Asian plantations.
Rubber plantation in Malaya (about 1947)
Collecting and grading latex
Transporting latex to factory
Coagulating latex
Forming sheets from coagulated latex
Rolling and pressing sheets of coagulated latex
Cutting and hanging latex sheets
Smoking latex sheets
Organizing and pressing crude rubber sheets for shipment
• Because of the war, and the fact that the Japanese controlled the plantations, much work on synthetic substitutes began.

• The Germans had already made several types of synthetic rubber.

• Much of this work was done here at the University of Illinois. Roger Adams and Carl "Speed" Marvel were early workers in that area.
• Several types of synthetic rubber were made. For some purposes they are better than natural rubber, but, for others, not as good.
• Despite this, use of natural rubber is greater today than at any time in the past.
• About 2/3 of all rubber goes into tires. Natural rubber is the best for airplane tires and is also important in radial tires.
• About $7 \times 10^9$ lbs of rubber per year are used in the U.S.
• About 30% of this is natural rubber.
• The market price (2007) is about $600$ US per ton ($$3.33$ per lb.).
• Synthetic rubber is made from petroleum derivatives, which is a problem for the future.
• Another major future concern is that the rubber plants in Southeast Asia are susceptible to the fungal disease that decimates rubber production in South America.
• At some point the disease is bound to get there. That will cause major problems for the economies of several countries.
Guayule, *Parthenium argentatum*, Asteraceae

- Because of the problems of W. W. II, another approach was to search for new sources of rubber.
- One plant, *Parthenium argentatum*, Asteraceae or Compositae, was examined during this period.
- The rubber from guayule is equal in quality to that of *Hevea brasiliensis*. The plant is a small perennial that grows in the northern deserts of Mexico and in southwest Texas.
Guayule, *Parthenium argentatum*, Asteraceae
• The rubber in this case is scattered throughout the plant.
• There is a resinous material that also occurs in the plants and it must be removed in processing.
• Attempts to cultivate the plant have not been entirely successful, but it appears as a promising rubber source.
Gutta-percha or balata

- This type of rubber has an all trans structure and has very different physical properties from natural rubber.
- Gutta mostly comes from *Palaquium gutta* (Sapotaceae) or other species from both the Old and New World.
- Gutta is used for golf balls and undersea cables.
- Gutta also is the material of choice for packing teeth in root canals.
*Palaquium gutta* (Sapotaceae) source of gutta-percha
• Balata rubber comes mostly from *Manilkara bidentata* (Sapotaceae) and is particularly good for making machine belts.

• Both gutta-percha and balata have largely been replaced today by synthetic materials.
Chiclé, *Manilkara sapota*, Sapotaceae

- The Indians of the Yucatan peninsula chewed chiclé, the latex of *Manilkara sapota* (Sapotaceae). General Santa Anna (who came from Yucatan and is best known for his actions at the Alamo) was confined to a small house in Staten Island for some time after the war of 1847. He left behind a package of chiclé.
Chiclé, *Manilkara sapota*, Sapotaceae
• His secretary, a Mr. Adams, gave the chicle to his father who marketed the material and it became popular (story on page 258). Chewing gum became popular. The trees are still tapped in the Yucatan and in northern parts of Central America.

• The latex is a mixture of cis- and trans-forms.