Polymers in daily life

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What is an atom?
原子って何

- Atoms are basic building blocks of everything you can see around you. (原子は皆さんの周りのすべてのものを構成している）
- Many things you cannot see, for example air that you breath.
- Atoms are so small that there are millions, billions and trillions in the tiniest speck you can see.
- Solids, liquids and gasses –all matter  (物質)-are made up of atoms.
What is a Molecule?
分子って何か

- Molecules are made up of atoms. 分子は原子から構成されています
- atoms can join together they form bonds together- to make molecules. For example two atoms of hydrogen hook together To form a molecule of hydrogen.
Now if we stick an oxygen atom in between two hydrogens, you have a molecule of water.

酸素原子が2個の水素原子と結合すると水分子になります。
What is a POLYMER?

- Large organic molecule formed by combining many smaller molecules (monomers) in a regular pattern.

- A long molecule that is made up of a chain of many small repeated units (monomers).

- Long chains of covalently bonded atoms.
schematic representation of a polymer

and so on...
Difference between polymer and low molecular weight compounds

- Low molecular weight compounds
  freely soluble in solvents (溶媒に容易に溶解)
  solution has less viscous (溶液の粘度が低い)
  Examples: sodium chloride (塩化ナトリウム), vitamins (ビタミン) etc.

- Polymers or high molecular weight compounds
  swell before dissolution (溶媒にさらすと溶解する前に膨潤する)
  Posses high viscous (高い溶液粘度)
  Examples: PE (ポリエチレン), PVA (ポリビニルアルコール), PMMA (ポリメタクリル酸メチル), PET (ポリエチレンテレフタレート) etc.
What are polymers?

Polymers are substances. These substances are either in liquid or solid forms.

Polymers are available in this world since beginning. Means polymers are not new. They are very old.

For example starch, cellulose and rubber all possess polymeric properties and are available since beginning of nature.

Man made polymers have been studied since 1832. Today polymer industries growing more than aluminium, copper and steel industries combined.
Types of polymers

- **Natural (天然高分子)**
  - Cellulose (セルロース)
  - Starch (デンプン)
  - Proteins (タンパク質)

- **Synthetic (合成高分子)**
  - PS, PET, PE, Nylon, PMMA, PHEMA.
Difference between natural and synthetic polymers

天然高分子と合成高分子の違い

- **Natural**
  - They are degradable (分解性である)
  - They are not processable (加工性が悪い)
  - They possess poor mechanical strength

- **Synthetic**
  - They are non degradable (一般に分解性が低い)
  - They are processable (加工性がよい)
  - They possess good mechanical strength. (優れた力学的な特性を示す)
Classification of polymers

- Plastics (プラスチック)
- Rubbers (ラバー、ゴム)
- Fibers (繊維)
- Paints (塗料)
Thermoplastics

Plastics at home (家庭の中での例)

- carry bags, containers, jars, insulators, nonsticky pans, soft drink bottles, matrices, tooth brush and paste etc.
How polymer articles will be prepared
どのようにして高分子は加工されるか

- There are four main techniques
- Injection molding (射出成形)
- Extrusion molding (押出成形)
- Blow molding (中空成形)
- Compression molding (圧縮成形)
Injection molding

The process of injection molding involves the following steps:

1. Clamp:
   - The mold is closed and held firmly in place.

2. Injection unit:
   - Melted plastic is injected into the mold.

3. Mold:
   - The plastic solidifies into the desired shape.

4. Heaters:
   - Heat is applied to the plastic to soften it before injection.

5. Pellets in screw motion:
   - Plastic pellets are fed into the screw and moved through the barrel.

The diagram illustrates the mechanical components and the flow of the process, emphasizing the interaction between the clamp, injection unit, mold, heaters, and pellets in screw motion.
Blow molding
中空成形
Rubbers
ラバー (ゴム)

- Latex is a milky white fluid extracted from bark of trees.  (ラッテックスは木の皮からとれる乳白色の液体である)
- It could form a solid that was elastic.  (ラッテックスから作られるゴムは弾性を示す。)
- If you rubbed it on penciled words, the writing would disappear, so it is named as rubber.
- This rubber become hard and brittle when it got cooled, a sticky mess when it got too warm.
- But when we heat rubber with sulfur would remain elastic at wide range of temperatures.
- Carriages, cars, trucks, and busses traveled billions of miles on tires made of v-rubber.
A rubber tree plantation in southern INDIA

南インドのゴムの木のプランテーション
New cut is made each night
Latex flow begins
ラテックスが流れ始める
Latex flow towards collection cup

液状ラテックスを容器に集める
Latex coagulation with dilute acid

希釈された酸でラテックスを凝固する
Water is rolled out of the rubber
Fresh and smoked sheet of raw rubber

生ゴムとその燻製物
Tajmahal, India.
Fibers

- Fibers are polymer like tiny little rods or tubes - 100 times longer than its diameter

- Any fiber that you can think of is a polymer.
- If it’s a metal, its called a wire not a fiber
- Fibers can be natural - from plant or animals, or synthetic made by people.

cellulose  cotton  wool
Nylon parachutes

ナイロンパラシュート
Paints or coating
塗料とコーティング

- Painting makes the product look beautiful and also protect from the corrosion.
- Paints to homes, buildings and class room walls etc.
- It also helps to clean easily
Blue city, India.
Applications of polymers

Agriculture and agribusiness

Super absorbent polymers

Polymeric substances are used in and on soil
To improve aeration (supply of moisture)
To provide mulch (to stop growing unwanted plants)
To promote plant growth and health.

Medicine

Many biomaterials, especially heart valve replacements,
Blood vessels are made of polymers like Teflon and Polyurethane.

Contact lenses (PHEMA, hydrogel)

Baby napkins
Cosmetics

- Cosmetic and personal care lotions, creams, sticks, etc.
- Useful in skin care, sun care, color care and hair care applications
Plastic containers of all shapes and sizes are made with polymer substances.

Clothing, floor coverings, garbage disposal bags and Packaging etc.

They are light weight and less expensive.
Industry

Automobile parts, handsets, windshielded for fighter planes, pipes, tanks, packing materials, Insulation, wood substitutes, Adhesives, matrix for composites, and elastomers.
Sports

スポーツ用品

Playground equipment, various balls, golf clubs, swimming pools, protective helmets.
Many natural polymers are present in our food. For example, soups, ice creams contain polysaccharide polymers such as starch, guar, etc. Cow’s milk is loaded with the polymer casein, a protein without this casein (polymer) cheese will be non-sticky.
Lotus temple, India
Most polymers will last a long, long, long, long time.

That's good - especially if you use them to make clothes, jars, even chairs.

But it's bad when polymers get thrown away.

It's important to recycle the polymers that we can, like drink bottles, so that our landfills don't get filled up so fast.
Continue recycling
リサイクルを続けると

• Recycling gives new life to the things we use. It can conserve valuable resources: landfill space, energy, raw materials.
What’s so great about polymers?

• Why would we want to use polymers to make stuff? What about other materials, like wood, metal, glass, or ceramics?

• Let's pretend that you own a company that makes apple juice. What would you use to make the bottles - metal, plastic, or glass?
Most of the polymers have the following properties

- Lighter
- Harder to break
- Long lasting
- Recyclable
- Easier to form into shapes
- Cheaper (1kg 100 - 500円)

By choosing the right kind of polymer, our product can be soft or hard, flexible or stiff, or most anything we want
Strength of the polymers 高分子の強さ

- We keep stretching the sample, increasing the stress (the force/area) until - snap! - it breaks. How much stress could it take? The stress needed to break the sample is the tensile strength of the material.

Strength of single polymer chain is higher than that of steel 一本の高分子の強さは鉄よりも強い
Varieties of shoes

様々な靴
Pool Palace

Hot tub

Swimming pool lining with PVC
Skate board
Sporting stuff
Auto parts
Recordings
Music shop
Food stuff
Polymers in medical field
医学分野での高分子

- Drug delivery (薬剤の徐放)
- Tissue sealants (組織接着剤)
- Wound dressing (創傷被覆)
Drug delivery from environmentally sensitive release systems

環境に応答する薬剤放出
Polymers are basic part of our daily lives they comprise the pipes and wires we used to get ready this morning.

The sheets and blankets that kept us warm last night.

Socks and shoes that protect our feet.

Polymer coatings play huge role in protecting the homes, buildings and class room walls etc.

Polymers entered in to biomedical field and solving many problems.
I am grateful to Japan society for the promotion of science (JSPS) for financial support as well as giving me an opportunity to deliver this lecture today.

Thank you
Traditional dresses in India.
Temples, India.