## **ScienceNews**

### **Teacher Background Sheet: Plastics**

#### The molecular structure of plastics

Before beginning the activity, brief students on the molecular structure of plastics. Plastics, also called synthetic resins, are human-made materials primarily composed of hydrocarbon molecules, which are molecules composed essentially of carbon, hydrogen and oxygen combined with other elements such as nitrogen, chlorine and sulfur. While most plastics are hydrocarbon based, silicones are plastics made of molecules composed of silicon, oxygen and other elements. Most plastics contain organic *polymers*, or substances made of repeating chains or rings of smaller, similar units called *monomers*. Monomers are chemically bonded into chains called polymers by addition reactions or condensation reactions. The various types of plastics are composed of polymers with <u>different structures</u>. The structure of each different type of plastic results in the different characteristics of the plastic, such as opacity, brittleness and strength. These characteristics define how each type of plastic can be used and whether it can be recycled.

There are two main types of plastics: thermoplastics and thermosets. Thermoset plastics form interconnected chemical bonds between polymers when initially heated, so the cooled plastic cannot be reheated and remolded after it forms. No chemical bonding occurs when thermoplastics are heated, so these materials can be reheated, remolded and cooled repeatedly without causing chemical changes to the substance.

Most "recyclable" plastics (those No. 1–6 and some No. 7 plastics) are thermoplastics. <u>Science Matters:</u> <u>The Case of Plastics</u> by The Science History Institute defines and describes plastics and provides illustrations of the structures of different types of plastics.

During the activity, students will encounter references to chemical processes that may be unfamiliar. In addition to the terms plastic, polymer, monomer, thermoset and thermoplastic, which are defined above, students should understand the following chemical processes.

**Polymerization** A chemical reaction in which two or more molecules combine to form a larger molecule that contains repeating structural units.

**Depolymerization** A chemical reaction in which a large molecule that contains repeating structural units is decomposed or broken down into simpler compounds, generally into smaller units of the repeating structural unit.

**Pyrolysis** A chemical change, generally decomposition or breaking down of chemical structures, that is caused by heating a material in the absence of oxygen.

**Dissolution** The process by which a solute (in this case, plastic) interacts with molecules of a solvent (such as an acid) and the solute separates into ions or molecules that are surrounded by molecules of the solute.

**Compatibilization** The addition of a chemical substance (the "additive") to a blend of polymers (plastics) that causes the different types of polymers to chemically interact in ways that increase the stability, and therefore the mechanical properties, of the mixture.

Note: Provide the following reference sheet, "Classifying Plastics," to students during the activity, as well as a completed class plastics inventory. A data table is included in this document for your convenience.

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### **Classifying Plastics**

Plastic products have numbered symbols stamped on them. These symbols indicate the type of resin the product is made of. The table below summarizes the seven resins from which most plastic products are made, identifies what percentage of each type of plastic is recycled and provides additional uses for each type of plastic.

Number	Name and acronym	Common products	Percentage	Possible post-
	of polymer		recycled	recycling uses
1	polyethylene terephthalate (PET or PETE)	packaging, cooking oil bottles, carpet, clothing fibers, tote bags	19.5	synthetic fibers for clothing, fabrics or carpets
2	high-density polyethylene (HDPE)	toys, grocery bags, cleaning supply bottles, playground equipment, credit cards	10.3	pens, plastic lumber, fencing, bottles, picnic tables, coatings, adhesives and binders
3	polyvinyl chloride (PVC)	pipes, house siding, fencing, flooring, toys, lawn chairs, cling film	0.0	flooring, house siding, pipes and building materials
4	low-density polyethylene (LDPE)	plastic bags, toys, six-pack rings, bubble wrap, pet food sacks, tubing, detergent or cleaner bottles	5.3	new plastic bags, garbage cans, flooring, bubble wrap and furniture
5	polypropylene (PP)	auto parts, toys, industrial fibers, drinking straws, food containers, furniture, luggage, dishes, toothbrushes	0.6	car parts, pallets, tools and milk crates
6	polystyrene (PS); expanded polystyrene foam (EPS)	plastic foam (such as Styrofoam), toys, clamshell containers, packing peanuts, insulation boards, costume jewelry	0.9	DVD and CD cases and trays, insulation and some school supplies
7	other (O); includes acrylic, nylon, polycarbonate, polylactic acid (PLA), and multilayer plastics	artificial fingernails, toothbrush and hairbrush bristles, dental floss, clothing fibers, bottles, safety glasses, toys, 3D printing filament	0.0	plastic lumber, building materials, park benches and picnic tables

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### **Class Plastics Inventory**

Type of plastic	Number of items	Percentage of plastic inventoried
No. 1 PET		
No. 2 HDPE		
No. 3 PVC		
No. 4 LDPE		
No. 5 PP		
No. 6 PS or EPS		
No. 7 Other		



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