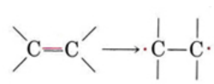
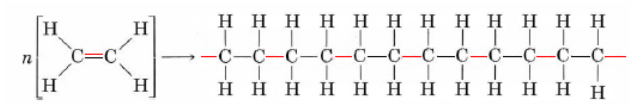
8.24: Addition Polymers

Addition polymers are usually made from a monomer containing a double bond. We can think of the double bond as "opening out" in order to participate in two new single bonds in the following way:



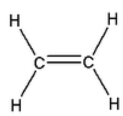
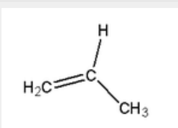
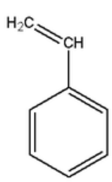
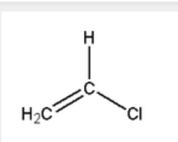
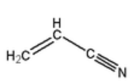
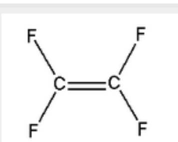
One of the lines in a double bond is highlighted in red. An arrow points from this double bond to a single bond in which each carbon now has one free electron each.

Thus, if ethene is heated at moderate temperature and pressure in the presence of an appropriate catalyst, it polymerizes:



Polymerization of ethene equation shows an indefinite amount of repeating ethene structure forming a long carbon chain.

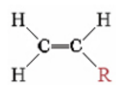
Table 8.24.1: Some Common Addition Polymers.

Monomer	Nonsystematic Name	Polymer	Some Typical Uses
	Ethylene	Polyethylene	Film for packaging and bags, toys, bottles, coatings
	Propylene	Polypropylene	Milk cartons, rope, outdoor carpeting
	Styrene	Polystyrene	Transparent containers, plastic glasses, refrigerators, styrofoam
	Vinyl chloride	Polyvinyl chloride, PVC	Pipe and tubing, raincoats, curtains, phonograph records, luggage, floor tiles
	Acrylonitrile	Polyacrylonitrile (Orlon, Acrilan)	Textiles, ruga
	Tetrafluoroethylene	Teflon	Nonstick pan coatings, bearings, gaskets

The result is the familiar waxy plastic called polyethylene, which at a molecular level consists of a collection of long-chain alkane molecules, most of which contain tens of thousands of carbon atoms. There is only an occasional short branch chain.

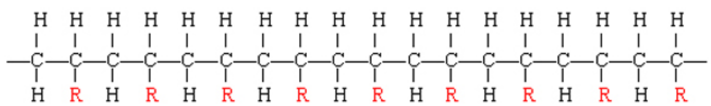
Polyethylene is currently manufactured on a very large scale, larger than any other polymer, and is used for making plastic bags, cheap bottles, toys, etc. Many of its properties are what we would expect from its molecular composition. The fact that it is a mixture of molecules each of slightly different chain length (and hence slightly different melting point) explains why it softens over a range of temperatures rather than having a single melting point. Because the molecules are only held together by London forces, this melting and softening occurs at a rather low temperature. (Some of the cheaper varieties of polyethylene with shorter chains and more branch chains will even soften in boiling water.) The same weak London forces explain why polyethylene is soft and easy to scratch and why it is not very ‘strong mechanically.'

The table above lists some other well-known addition polymers and also some of their uses. You can probably find at least one example of each of them in your home. Except for Teflon, all these polymers derive from a monomer of the form.



Structure shows "C" double bond "C". One "C" is single bonded to two "H". The other "C" is bonded to 1 "H" and one other "R" group.

The resulting polymer thus has the general form:



Repeating pattern in polymer show "C" "H" 2 single bond "C" "H" "R" single bond "C" "H" 2 and so on.

By varying the nature of the R group, the physical properties of the polymer can be controlled rather precisely.