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**Polymer - Fundamentals**

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**Acknowledgement**

Mr John Gibson is a highly regarded educator and engineer. John taught Industrial Arts at a number of high schools before taking a position at Sydney Teachers’ College, then University of Sydney. He had an engineering education consultancy and has extensive experiencing working with NESA on Engineering Studies syllabus development and the HSC examination committee. The STEM Industry School Partnerships (SISP) Program asked John for his responses to the iTeachSTEM topic discussion questions. SISP is grateful to John for submitting these example discussion responses.

# Describe features of thermosetting polymer.

* undergo a chemical change which anchors the chain molecules with covalent bonds
* structure is 3D
* when cooling, the polymer becomes hard and stiff. Example: Bakelite

1. **Describe features of thermo-softening polymers.**

* structure is built with covalent bonds that are strong
* adjacent chains are attracted to one another by weak Van der Waals force
* with heat, or stress, these molecules can move over one another to allow deformation
* are called thermoplastics. They soften when hot. Example: Polyethylene

1. **Describe features of an elastomer.**

* based on a chain structure of covalent bonds, but the chains are long, soft, flexible and twisted.
* with the addition of external forces, such as tensile force, the chains are able to stretch a number of times their static length and return to their original length if released.

1. **Why are polymers suitable for shaping into complex shapes?**

* some are flexible in three dimensions, and can be moulded with low levels of heat or mechanical force
* they are liquid and can be coated over a heated die to cool

1. **Describe types of polymer shaping processes:**

* blow moulding – heating a tube of polymer in a mould, where low air pressure in the tube blows the plastic against a mould, like a balloon. Example: plastic bottles
* vacuum forming – heating a sheet of thermoplastic over a pattern, creating a vacuum under the sheet allowing it to be drawn over the pattern. Example: plastic cutlery drawers
* injection moulding – forcing a softened thermoplastic under pressure through a shaped die. Example: PVC drain pipe
* extrusion – the process of applying heat and pressure to melt polymers such as polyethylene. The polymer is forced through a die to produce continuous shapes of the profile or pipe
* compression moulding – polymer powder is placed in a mould under heat and pressure, hardens. Example: Bakelite products
* calendaring – production of large thin sheet polymer plastic. Polymer is worked between heated cylindrical rollers, drawn into sheet, and cooled. Example: ‘builders’ plastic

1. **When drawing a macrostructure of a polymer, what is the significant difference between a thermosetting and a thermos-softening polymer?**

* thermosetting polymers: have a rigid structure showing covalent bonds in three dimensions
* thermoplastic polymers: have a flexible chain structure, held together with Van der Waals forces