INVESTIGATION OF THE FORCE – EXTENSION RELATIONSHIP FOR RUBBER

Specification reference: **AS Component** **1.5 - Solids under stress**

A level Component **2.5 - Solids under stress**

Theory:

Rubber – an example of a polymer with weak cross bonds. Natural rubber is a polymer of the molecule iso-prene. It has weak van der Waals cross-bonds and only a few covalent (strong) cross-bonds.

Apparatus:

Rubber band of cross-section approximately 1 mm by 2 mm
Clamp and stand
G-clamp to secure (if required)
50 g mass holder plus a number of 50 g masses
Optical pin (for use as a pointer if required)
Metre rule (resolution ± 0.001 m)
Micrometer (resolution ± 0.01 mm)

Further guidance for technicians:

Hoffmann clips are useful to suspend the rubber band, and, if you wish, to attach the masses. The dimensions of the elastic band are only approximate and don't need to be exact.

Experimental Method:

Hang a (cut) rubber band of (approximate) cross-section 1 mm by 2 mm vertically from a stand, boss and clamp. The base of the stand should be secured using a G-clamp. Hang a 50 gram mass holder from the band. Place a metre rule as close as possible to the mass holder. The length can be read using an optical pin attached to the base of the mass holder. Measure the length, width and thickness of the rubber when it is supporting the 50 gram holder. Try to avoid squashing the rubber with the micrometer screw gauge.
Increase the mass in 50 gram steps, measuring the extension each time. Continue until the band breaks.
Plot the force - extension curve and determine the Young modulus from the linear section.

Extension:

A similar experiment could be carried out on polyethene and a comparison of the two curves made. Another investigation could be made comparing the properties of the plastic shopping bags from various supermarkets. Measurements could be taken when unloading both the rubber band and the polyethene and the hysteresis determined.

Practical Techniques:

- Use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings.
- Use methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line.
- Use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data.