Plastic disposables in the laboratory

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Plastic disposables have become essential equipment in most medical and industrial laboratories. The benefits they offer in cost, sterility and safety suggest that this trend is likely to continue.

THE large volume of samples generated by the increase in testing and analysis work in modern laboratories has created an increased demand for disposables. The glass 'laboratory durables' used for many years had a guaranteed life expectancy of ten years, and often lasted for fifty years or more. Today's plastic laboratory disposables, in contrast, are designed to be used once and then be thrown away.

By the time plastic Petri dishes and other early laboratory disposables began to appear on the market in the early nineteen fifties, the concept of disposability was already well accepted. It was the arrival of auto-analysis equipment designed specifically for use with plastic or glass disposable 'accessories', however, which started the current era of laboratory disposables.

The properties of early plastics were very limited. While some were flexible enough to be formed into a variety of shapes, they lacked heat resistance and clarity, and this restricted their potential applications. The development of more sophisticated tools and machinery for manufacturing plastics brought the production of plastics from a primitive chemical process to an industry of high precision engineering, with the capability to design and mould accessories to almost any specification. Advances in plastics technology have now created a new generation of disposables with better resilience, heat resistance, clarity and surface properties that compete with traditional disposables made of glass. The range of plastic disposables available today includes such basic items as Pasteur pipettes and test tubes, as well as precision pipettes and centrifuge tubes that can withstand up to 8,000 RCF.

Composition

The majority of plastic disposables are moulded or extruded from polystyrene, polypropylene and polyethylene (Table 1). Polypropylene differs from polystyrene and polyethylene because it is autoclavable and has the ability to withstand temperatures of up to 135 °C. Polypropylene and high density polyethylene can both withstand chemical sterilization with substances such as benzalkonium chloride, formalin and ethanol. Although polystyrene cannot stand up to extreme heat and strong chemicals, it has a high level of optical clarity.

Another new plastic, polycarbonate, is extremely resilient and has excellent optical clarity. Polycarbonate is classified as an engineering thermoplastic, because of its toughness, exceptional clarity and high heat resistance. It is made in an interfacial process by a reaction between bisphenol A and carbonyl chloride. Characteristics of this plastic include a heat deflection temperature of 130 °C and 87–91 per cent light transmission, and its impact properties make it ideal for centrifuge tubes.

One of the latest materials to be developed is very low density polyethylene (VLDPE) which can be drawn into thin film and does not tear easily. This new class of linear polyethylene polymer has a density range of 0.890–0.915 g cm^{-3}. VLDPE has greater flexibility than the other low density linear polyethylenes — such as the lower strength material EVA and plasticized PVC — but does not provide their toughness and broad operating temperature ranges. VLDPE can be used to produce thin films as low as 0.2 mm in thickness, and is suitable for applications requiring a soft, flexible material for disposables such as gloves and health-care products.

Table 1 Physical properties of plastic disposables

	Polystyrene	Polypropylene	High density polyethylene
Autoclavable	No	Yes	No
Brittle temperature	0 °C	0 °C	– 100 °C
Chemical sterilization*	No	Yes	Yes
Dry heat sterilization at 180 °C	No	No	No
Gas sterilization, ethylene oxide	Yes	Yes	Yes
Heat distortion temperature	70 °C	135 °C	121 °C
Specific gravity	1.040	0.903	0.944
Transparency	Clear	Translucent	Opaque

*Benzalkonium chloride, formalin, ethanol.

Precision

Disposables for liquid measuring and delivery, such as pipettes, require a high degree of precision in manufacturing to ensure that they are made to exact dimensions and will dispense exact volumes. Accordingly, precision plastics are made from high-quality components with specific constant properties.

The production of plastic disposables is backed up by strict quality control procedures. During manufacturing, pipette tips are subject to eleven different quality control procedures, and are screened according to uniformity of orifice geometry, cleanliness of hydrophilic surfaces, appropriate length and colour, and zero ovality. They are also tested for excess plastic residue, known as flash.

Plastics are able to deliver the precision required and still retain their benefits of low cost and disposability. A typical example is the micropipettor, where precision engineering is used to design the non-disposable plunger unit, while contact with liquids is restricted to the disposable pipette tip. Tips are usually made of polypropylene, which can be polished to a high gloss to avoid retention of liquid which might prevent a precise delivery.

The latest techniques in plastic manufacturing are producing disposables with specific surface properties. This type of disposable is very useful in tissue culture, where the surfaces of culture dishes must be specially treated to encourage the growth of a uniform monolayer of cells. The treatment of plastics has also produced multi-well plates which allow antigens to bind to their surface, making possible new immunological techniques such as ELISA and RIA.

Limitations

The applications of plastic disposables are limited by their moderate resistance to heat and chemicals. Although plastic tubing, for example, can be used with a strong base such as concentrated sodium hydroxide or a strong acid such as concentrated hydrochloric acid, it is not recommended for use with chemicals such as benzaldehyde, ethylene dichloride, acetic acid, ethers, concentrated sulphuric acid, lacquer solvents and perchloric acid. The manufacturers of plastic disposables provide safety guidelines for the storage and use of chemicals in conjunction with plastic products to prevent accidents arising from misuse.

The future in new plastics technology lies in the development of disposables to meet the changing requirements of the modern laboratory. The cost of raw materials and the introduction of stronger polymers will be determining factors in the future of disposables. □

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