Medical marvels

One of the most challenging applications for packaging is in the medical field. Exacting levels of sterility are called for when packing pharmaceutical products, medical devices and tissue grafts. In the case of some pharmaceuticals, the package sometimes also functions as a sophisticated dispenser.

A recent innovation of this type is a three-compartment flexible plastic bag that stores the powder and diluent's components of an intravenous drug solution in the same package. Until now the two products have been packaged separately, the powder in a glass vial and the liquid in a conventional intravenous drip bag. A nurse would add the powder to the liquid, mix them together, and then attach an intravenous drip tube to the bag.
With the new design, the nurse squeezes the upper compartment holding the diluent. This bursts a seal and mixes it with the powder in a central chamber. Once the two are sufficiently mixed, the nurse then squeezes the second chamber until a second seal breaks. This transfers the solution to a third chamber which connects to the tube that goes to the patient.
The product is an example of how different plastic polymers, used in conjunction with other materials, can be used to develop highly sophisticated packaging technology. The package is made with a blend of polypropylene (PP) and synthetic elastomer. On its front side there is a layer that is a laminate of poly (ethylene terephthalate) (PET) and aluminium. The drug compartment has a peelable, high-barrier foil consisting of two types of plastic, PET and ethylene vinyl acetate (EVA), together with a layer of aluminium. This protects the drug from moisture and oxygen. It can be peeled off so that the drug can be inspected before mixing. Under this peelable layer there is an additional, clear, high-barrier material which protects the drug for a limited time after the peelable layer has been removed. This clear barrier is a laminate of PP and PET that has a silicon oxide coating.

Products taken by means of inhalation are an example of packaging that also functions as a dispenser. People suffering from asthma need a convenient portable package that dispenses the product in the right quantities. The device illustrated here generates precisely metered doses of the medication, delivering the product using only the patient's breath, and eliminating the need for

propellants. The inhaler also provides the patient a visual indication of the remaining doses. As with the intravenous solution bag, this innovation is made possible by combining the different and specific functionalities of different polymers.

Now well established in Europe and recently receiving approval in the USA is the disc-shaped inhaler, shown here dismantled. This too counts the doses that have been administered and gives the user a precise indication of the number remaining. Standard doses of a dry powder medication are contained in a blister strip. Like the other inhaler, the complex engineering of the device is made possible by combining different types of plastics, each with specific properties.

A very different but equally demanding medical application is the packaging of human tissues. Superior low-temperature properties, combined with a high level of resistance to bacterial penetration and moisture migration mean that a specially designed plastic film can be used to package some of the most precious medical items of all, human tissue intended for transplantation. To produce the film, continuous strands of very fine, interconnected polyethylene fibres are randomly oriented and then bonded together by heat and pressure. The fibres are about 1/20th the diameter of a human hair. Because of its unique structure, although porous, the material is highly resistant to penetration by bacteria, spores and other contaminating micro-organisms. The picture, which shows microbes trapped on the surface of the fibres, is at 500 times magnification. Highly tear-resistant, plastic packaging material of this type is especially suited to the packaging of tissues because, unlike replacement organs, which must be rushed from donor to recipient within a few hours, many tissue grafts can be stored frozen at -70^{0}C or lower or freeze-dried and stored at room temperature, in both cases for as long as 5 years. Glass vessels have been the traditional container for both types of storage, but these are now being replaced with flexible plastic pouches.