1 The new materials

The UK window market is now comfortable with the existing materials choice but this was also the case in the late 1970's before PVC-U appeared and changed the market completely – aluminium declined, wood declined even more rapidly and steel became a niche market. Since then PVC-U has reigned supreme and again complacency has set in. The PVC processors have so much investment tied up in the current equipment that change has become something to be feared instead of something to be embraced. Despite this, new materials are being developed and some of these could threaten the current stranglehold of PVC.

These new materials present both opportunities and threats to the existing industry - with new materials and new product development the advantage often lies with the attacker - they have less to lose and more to gain. However, new materials will face more than technical barriers because better moustraps do not always take the market by storm and the sellers of the current materials will not give up market share easily.

The development costs and simple chemistry make it unlikely that new polymers or metals will be developed for windows. The areas to watch are those where composites or compounds of existing plastics are developed to extend properties and reduce costs. These new composites will use either low cost fillers to marginally stiffen and fill the matrix or high cost reinforcements to greatly stiffen and reinforce the matrix. The new materials may also defy the conventional categories for materials.

2 Wood plastic composites (WPCs)

WPCs are a new material type and a wide range of new materials is being developed. The plastics being used include PP, PE and PVC and the fillers used include sawdust, wood flour, flax and jute. This range of raw materials gives a wide range of properties and the high wood content of some products (up to 70%) can lead to confusion - is it wood or is it plastic? Timber and plastics may come together as both wood and plastics processors transform themselves into composites companies. Applications are not restricted to window products and include car body panels and parcel shelves. WPCs may well be the material of the future for more than just windows.

The majority of the work on windows is being carried out in the USA and finished products are already being marketed there. As yet there is little commercial activity in the UK but this should come as the benefits of WPCs are recognised. In the USA, the major producers are timber window manufacturers who have access to large quantities of sawdust and wood that is suitable for use in WPCs. This means that no wood resources are depleted in producing WPCs and waste products are now a valuable resource - recycling can be both profitable and ethical. The sources of the base plastic vary depending on the process but ranges from recycled PE bags and PP battery cases to the use of virgin polymer.

WPCs can generally be nailed, painted and otherwise treated as wood whilst retaining many of the benefits of plastics in the areas of fungus and corrosion resistance.

WPC materials reduce costs, increase production rates and offer a host of benefits to the profile production. One of the virtuous areas is that the more wood that is added, the lower the price of the raw material and also the higher the stiffness of the raw material. Lowering the cost actually improves the performance.

Typical of the products that are being developed in the UK are:

Fibrex – Heywood Williams Group / Andersen Corp.

Andersen launched a wood-fibre reinforced PVC in 1993 under the name of 'Fibrex'™. The technology has been licensed in the UK by Heywood Williams and is scheduled for release in the near future. The product is a WPC (40% wood and 60% PVC-U) with a co-extruded virgin PVC outer layer.

Timbaplus

Timbaplus is currently producing a suite of WPC door profiles in the UK. The product is already undergoing testing and certification for the UK building products market.

Strandex

Strandex does not actually produce product in the UK but is actively trying to license the Strandex process as used in the USA. The final product is a WPC (70% wood and 30% PVC-U) and profiles can have a co-extruded outer layer of PVC for cosmetic purposes.

Plastics and cellulose material composites	
Positive	**Negative**
➢ Low cost and plentiful raw materials. ➢ Recycled raw materials. ➢ Hybrid materials - combine the best properties of both the biological materials and polymers. ➢ Good stiffness.	➢ Compatibilisers raise costs. ➢ Affects all current technology investments. ➢ Need to learn how to handle new materials (powder and dust).
These may well be the 'new composite materials' for windows with a wide range of features and benefits. Patents may well restrict development until the market settles down.	

The materials have lower and more stable costs, are environmentally friendly and have a wide range of features and benefits for all sectors of the market. The 'timber' window may well return to compete with (and possibly defeat) PVC-U.

3 Pultrusion

Pultrusion has been investigated many times in the past but is yet to achieve market commercialisation in windows. Pultrusions offer high dimensional stability, low thermal conductivity, high corrosion resistance and a high modulus of elasticity. The main disadvantages are cost, low workability and the some difficulty in producing the fine surface details needed (although there have been significant improvements in surface quality recently).

Pultrusion	
Positive	**Negative**
➢ High modulus of elasticity. ➢ High dimensional stability. ➢ Low thermal conductivity. ➢ High corrosion resistance. ➢ Colour possibilities.	➢ High perceived cost. ➢ Low workability. ➢ Some difficulty with fine surface details.
Great potential for window and door applications where the high stiffness greatly improves the product characteristics.	

The disadvantages have not stopped the development of some high quality window and patio door systems. The cost of a pultrusion may be higher than an equivalent length of PVC-U but the high stiffness means that no reinforcement is needed and this reduces both the raw materials and labour costs for the final product. Potential applications are for windows and doors where high stiffness, high load bearing and extreme chemical or thermal inertness are required.

Companies such as Crown Fenestration and Lindmann are currently offering pultruded products for sale in the UK.

4 Thermoplastic pultrusion

A thermoplastic pultrusion is a 'PVC-U extrusion locally stiffened by continuous glass fibre'. These products were developed through a PERA Craft Project and patents have been applied for the resulting process and products. The material uses localised glass fibre strands encapsulated in a PVC-U matrix by co-extrusion. The glass fibres added to the PVC-U matrix give a composite with high strength and modulus and the PVC-U enables details and surface finishes similar to conventional extrusions.

Thermoplastic pultrusion	
Positive	**Negative**
➢ High modulus of elasticity. ➢ Conventional PVC-U surface details and properties. ➢ Conventional process technology.	➢ Cannot be structurally welded and requires additional fastening for mechanical strength. ➢ Patented technology.
Good potential for products such as conservatory roofs where the high stiffness can be used effectively.	

Potential applications include conservatory roof bars and similar products that do not require welding to form a frame structure.

5 Polystyrene based materials

Polystyrene structural foams have often been proposed as window frame materials. They have a 'wood like' finish and advantages such as workability similar to wood, low cost and the ability to be produced on conventional single screw extrusion lines from a variety of recycled and virgin materials.

Polystyrene based materials	
Positive	**Negative**
➢ Good workability. ➢ Low cost tooling and processing. ➢ Wood-like finish.	➢ Some concerns with fire response. ➢ No successful commercial window applications known to date.
Process has been in existence for some years and current products suffer from the experience of poor performance with earlier similar products.	

The greatest disadvantage is the fire response of the product, adding fire retardants improves the performance but as with any polystyrene based material, the products 'drip and burn' when subjected to real flame testing.

6 ABS/ASA materials

In the USA, GE Plastics have developed an ABS/ASA composite as a window frame material; this uses ABS as an inner layer and an ASA co-extruded outer layer to improve the weather resistance. Despite the current price differences, it is claimed that ABS/ASA composites can use the same production machinery to produce thinner walled products run 30-40% faster with better physical properties than the equivalent PVC-U products.

ABS/ASA materials	
Positive	**Negative**
➢ Lighter weight than PVC-U for same stiffness. ➢ Conventional process technology but runs	➢ Higher cost than PVC-U. ➢ Needs ASA layer for UV and weather

faster than PVC-U. ➢ Good surface finish.	resistance but exceptional performance is achieved. ➢ Cannot be structurally welded.
A conventional process using a newly developed material and technology in an attempt to enter the window market. Probably matched in all benefits by other materials, which are better established and cheaper.	

The process has been developed and tested with trial products in the USA but little progress has yet been made in Europe.

7 Cellular PVC-U

Cellular PVC has long been used in the UK for trim and finishing but is now being used in the USA for mainframe window products. The products can be treated like wood but have the corrosion and fungus resistance properties of PVC-U.

The cost is low, the mechanical properties good and the technology is common with the existing extrusion technology.

Cellular PVC-U products	
Positive	**Negative**
➢ High thermal efficiency. ➢ Can be nailed, screwed and treated as wood. ➢ Conventional process technology. ➢ Other properties as per PVC-U.	➢ Cannot be structurally welded. ➢ Lack of detailed surface features. ➢ Price may be a disadvantage.
A process already used for ‘roofline’ and trim products but not yet used in the UK for full window and door systems. Good possibilities for the future.	

8 What now?

New low cost materials will revitalise, threaten and change the industry and give a huge advantage to the first companies to develop the products. Many companies in the UK are not developing products purely because of their current investment in existing technology. This will change in the future as low cost materials enter the market and compete against the existing materials. Staying in a particular technology simply because of your investment in the technology is not a recipe for success in any fast moving market and the window market is no exception.

The way ahead for new materials is not a simple one but it will certainly be interesting.

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