One of the significant events of recent years in the adhesives industry has been the development of rubberised or toughened epoxies and acrylics. By this means such desirable properties as tolerance to oily surfaces, the ability to bond dissimilar surfaces over a wide temperature range, high peel strength and impact resistance have been conferred to both systems.

In the case of epoxies, a low molecular weight rubber with functional terminal groups can be pre-reacted with some of the epoxy groups of the epoxide resin. This adduct is still epoxy-functional and so can react with the usual curing agents, amines, amides, anhydrides. But now the properties of the cured polymer have been modified by the inclusion of the rubber, not merely blended in but reacted in.

The rubber is reacted into the acrylic adhesive by different means. It has many reactive sites along the length of its molecule. Each is capable of initiating the growth of an acrylic chain e.g. of methyl methacrylate by a free radical reaction. Such chains
terminate when they meet similar chains and so a graft copolymer, a rubberised Perspex, is produced.

In each case the rubber forms a separate internal phase with particles as small as 0.1 microns in diameter, yet the particles are reacted chemically with the external phase and so modify bulk properties. Were they to be discrete they would contribute very little.

Such networks, acrylics or epoxy, offer the ability to dissipate the applied stress over the whole bond area; a crack propagating through the hard phase is stopped on reaching a rubber microsphere.

Epoxy adhesives can be single part, heat cured using a sterically hindered, unreactive curing agent like dicyan-diamide or two part, room temperature curing using amines or amides. None of this changes with the rubber adduct. We shall now follow the fate of this idea through various applications, some where one would not have thought at first sight that the rubber had a role to play.

Bostik E5207, E5210 and E5238 are single part heat cured epoxies whose properties are shown in Table 1. They comprise a series whose only variable is the amount of reacted rubber. Up to about 15% the cured adhesive is brittle and so, although the shear strength at elevated temperature is high, the adhesive is unsafe and E5207 was abandoned. With increased rubber content, the peel strength and impact resistance increase, the shear strength at high temperatures decreases but not markedly.