The practical uses of chemical adhesion in interlayer bonding

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The growing use of inert materials leads to novel problems regarding adhesion between layers. Of the established mechanisms in adhesion theory the use of chemical adhesion is the one which is both widely understand but equally misused. The strict criteria required for true chemical adhesion are rarely met naturally and the effects of other bonding modes are often assumed to be due to chemical bonding. The need for a reactive substrate and reactive coating as well as a mutually compatible reactivity profile is essential if it is wanted to achieve chemical adhesion.

It is possible to tune the properties of the substrate to allow chemically reactivity by utilising surface modification to "match up" the surface chemistry present in the substrate to that of the reactive coating. The use of surface modification to introduce an adhesion promoter for increasing the bonding strength of adhesives or coating is well known. An adhesion promoter is a bi-functional compound that can react chemically with both the substrate and the adhesive. The promoter can be applied either by mixing with the adhesive or by applying the promoter directly to the substrate surface by a suitable method. Unlike priming systems, adhesion promoters tend to be applied at thinner nm film thickness. For inorganic substrates this process is well documented through the use of "adhesion promoters" such as silanes (Figure 1), self-assembled thiols and phosphonic acids.

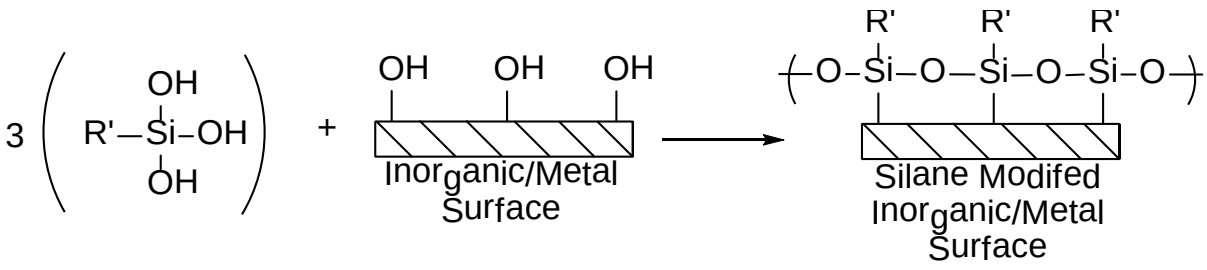

Figure 1 Silane modification

This process has been used to great effect in areas such as composite bonding of glass fiber to epoxy resins.

Although many techniques exist for the modification of high surface energy materials and certain reactive organic substrates there are fewer techniques that can applied to low surface energy, solvent and chemical inert materials. The use of highly reactive chemical intermediates such as carbenes is one method for chemically modifying inert materials. This process is unique due to the wide range of chemical reactions a carbene intermediate is capable of undergoing (figure 2).

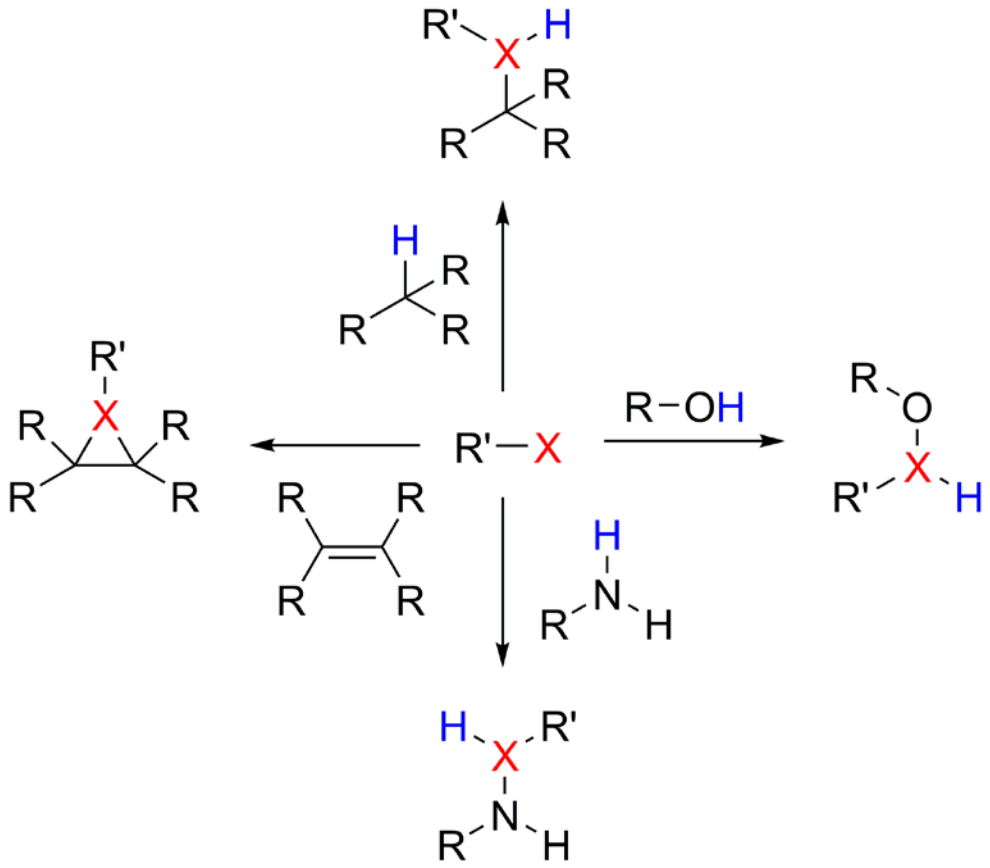

Figure 2 Reactivity profile for a carbene intermediate (X)

By utilising a compound which contains more than one reactive carbene intermediate it is possible to achieve chemical adhesion between not only an inert substrate but also an inert coating. This is demonstrated by the uplift in adhesion observed in a Polyester-fluoropolymer coating system when a reactive carbene cross-linker is used.