How Chemical Structures Affect Bond Strength

Ideally, an adhesive will form a chemical bond with functional groups bound on the surface of the material you wish to coat. The bonds, from strongest to weakest, are classified as ionic, covalent, Van der Waals, and London secondary forces. Ionic and covalent are structural bonds with shear values of around 1,000+ lbs/in.2. Van der Waals and London secondary forces are nonstructural bonds, normally yielding shear adhesion below 1,000 lbs/in.2. Peel adhesion derived from these bonds for pressure sensitive adhesives is very low. The peel adhesion value for heat-activated adhesives is about 10 to 50 lbs/linear inch.

The key to selecting an adhesive is related to the surface free energy of the material you wish to coat. Surface free energy derives from the unsatisfied bonding potential of molecules at a surface, giving rise to 'free energy'. This is in contrast to molecules within a material that have less energy because they are subject to interactions with like molecules in all directions. Molecules at the surface will try to reduce this free energy by interacting with molecules in an adjacent phase. Surface free energy values are tabulated in the literature for most metals and plastics. Normally, metals exhibit higher surface free energy than plastics. Polar plastics such as nylon, polyesters, and polycarbonates have higher surface free energy than non-polar plastics such as polyethylene, polypropylene, and most thermoplastic elastomers. These non-polar plastics are frequently corona or plasma treated to enhance polarity and reactivity.

Adhesion depends upon attaining close contact of the adhesive functional groups to those the surface you wish to coat. This contact can only occur while the adhesive is liquid, under pressure, and has mobility. Of course, because the functional groups within the material being coated are in a solid state, they have very little mobility. Thus, the adhesive must seek the surface groups and bond to them. Spacing of the functional groups on the polymers is critical to maximize bonding. Therefore, selection of an adhesive base having similar functional group spacing to the material you wish to coat (and proper reactivity) increases the probability of a good bond. For example, the adhesive for bonding polyethylene should have segments of polyethylene. If the material is metal, then the adhesive should also have segments of a polar nature. Ethylene vinyl acetate (EVA) is a versatile polymer used for bonding non-polar polymers (polyethylenes) to metals such as aluminum, while polyurethane adhesives can be used to bond polar plastics (polyesters) to metal.