Description

Process schematic

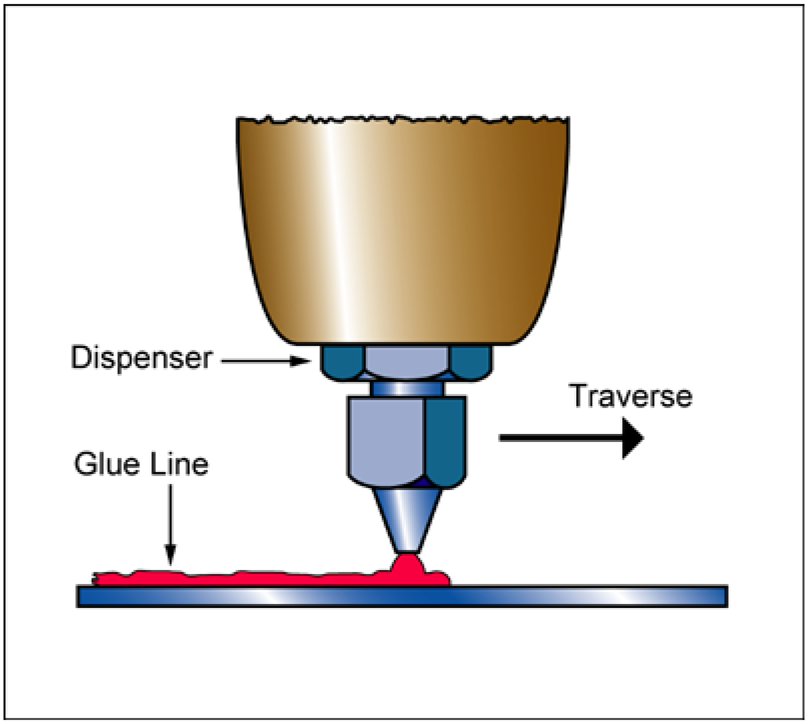

Figure caption

Adhesives are applied by spraying or with a dispenser

The process

Structural adhesives are those with a mechanical function, though they may have a secondary role as a sealant. They are now used in every industrial sector. Some are flexible (see record for Flexible Adhesives) but most are rigid, giving a stiff bond. Within each group, it is usual to use a classification based on chemistry.

Epoxies and epoxy-phenolics are thermosetting adhesives with high tensile strengths (up to 45 MPa) and low peel strengths (1.8 kg/mm). They are resistant to solvents, acids, bases and salts. Nylon-epoxies have the highest strengths and are used primarily to bond aluminum, magnesium and steel. Epoxy-phenolics retain their strength up to 150 - 250 °C and are used to bond metals, glass and phenolic resins. Most are two-part systems, curing at temperatures between 20 - 175 °C, depending on grade. They are used in relatively small quantities because of price: but, with imide-based adhesives, they dominate the high-performance adhesives markets. They give good adhesion to a wide range of substrates, with low shrinkage and good mechanical properties from -250 to +250 °C.

Acrylic adhesives are two-part systems that form a strong, impact resistant bonding layer when mixed or activated by UV radiation. They are durable, tough, water resistant, optically clear, and able to bond a wide range of materials. They are most used for wood-to-metal bonds.

Cyanoacrylate adhesives are familiar as 'super glue'. They are single part systems that cure in seconds when exposed to damp air, to give a strong, rather brittle bond. They bond to practically anything, and do so 'instantly' requiring no heat or clamping.

Phenolic adhesives are as old as Bakelite (1905), which they resemble chemically. Phenolics are sometimes blended with epoxies and neoprenes. They have high strength, good water resistance and heat resistance, and are flame retardant.

Imide-based adhesives (dismaleimides, BMI and polyimides, PI), like epoxies, are widely used as a matrix in fiber-reinforced polymers. They have better elevated temperature performance than most other organic adhesives. Used to bond ceramics and metals. They have excellent dielectric properties (hence their used in radomes); BMIs can be used at temperatures as low as -250 °C and as high as 230 °C; PIs up to 300°C.

Tradenames

Araldite

Material compatibility

Ceramics	✔
Composites	✔
Glasses	✔
Metals - ferrous	✔
Metals - non-ferrous	✔
Natural materials	✔
Polymers - thermoplastics	✔
Polymers - thermosets	✔

Function compatibility

Electrically conductive	✘
Thermally conductive	✘
Watertight/airtight	✔
Demountable	✔

Joint geometry compatibility

Lap	✓
Sleeve	✓
Scarf	✓

Load compatibility

Compression	✓
Shear	✓
Bending	✓
Torsion	✓
Peeling	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	low
Labor intensity	low

Physical and quality attributes

Range of section thickness	0.394	-	3.94e3	mil
Unequal thicknesses	✓			
Processing temperature	50	-	347	°F

Process characteristics

Discrete	✓
Continuous	✓

Supporting information

Design guidelines

Adhesives have a number of features that allow great design freedom: almost any material or combination of materials can be adhesively bonded; they can be of very different thickness (thin foils can be bonded to massive sections); the processing temperatures are low, seldom exceeding 175 °C; the flexibility of some adhesives tolerates differential thermal expansion on either side of the joint; adhesive joints are usually lighter than the equivalent mechanical fasteners; and adhesives can give joints that are impermeable to water and air. The main disadvantages are the limited service temperatures (most adhesives are unstable above 190 °C, though some are usable up to 250 °C), the uncertain long-term stability and the unpleasant solvents that some contain. CHOICE OF RIGID ADHESIVE Metals: Acrylic, Anaerobic. Cyanoacrylate. Epoxy, Phenolic, Woods: Acrylic, Epoxy, Phenolic, Hot-melt, PolyvinylacetatePolymers: Acrylic, Cyanoacrylate, Epoxy, Phenolic, Epoxy, Polyvinylacetate Elastomers: Acrylic, Cyanoacrylate, Epoxy, Phenolic Ceramics: Acrylic, Cyanoacrylate, Epoxy, Polyvinylacetate, Ceramic Fiber-Composites: Acrylic, Cyanoacrylate, Epoxy, Polyimide, Polyvinylacetate, Phenolic Textiles: Polyurethane, Hot-melt, Acrylic, Polyvinylacetate, Polyurethane.

Technical notes

Adhesive joints resist shear, tension and compression better than tear or peel - these last two should be avoided. Typical lap shear strengths of rigid adhesives are in the range 8 - 45 MPa. For joints loaded in shear, width (normal to the direction of shear) is more important than length (parallel to the shear direction). Butt joints are practical only when the area is large. Thin bond lines (typically 25 microns) are best, except when high impact strength is required. The essential equipment for adhesive bonding includes hot glue-guns and caulking-guns, both of which are used to apply adhesives essentially in a paste or semi-liquid form. Spray guns are used to apply liquid adhesives and can be automated. Brushes and sprays are used for manual application.

Typical uses

General structural use, metal/metal joints, aerospace industry (metal/metal, metal/composite and honeycomb structures), transportation industry (cycles, automobiles, railway), buildings and public works, electronic and electrical industry, leisure industry, DIY, manufacture of plywood, chipboard and laminated wood structures; abrasive fields and brake pads; foundry use for sand binding.

The economics

Adhesives offer low-cost assembly

The environment

Good ventilation is essential wherever adhesives are

Links

MaterialUniverse

Reference