HVM Catapult Adhesives Capability

Introduction

Adhesives today comprise of many different chemistries, each offering tailored properties for ever increasing and more demanding applications. Whether it be bonding silicon chips into discrete electronic packages, adhering skin after surgery, joining wood or plastic in construction or bonding face skins to honeycomb cores for aerospace, adhesives offer benefits and versatility over traditional fastening methods.

Process Summary

The vast majority of adhesives are polymeric in nature, e.g. carbon based such as epoxy, or silica based such as glass and cement. There are 6 recognised forms of adhesive bonding which may occur in a variety of combinations:

1. Physical adsorption using Van der Waals forces;
2. Chemical bonding through formation of covalent, ionic or hydrogen bonds;
3. Diffusion, where materials in contact may diffuse across the boundaries of the bonding surfaces;
4. Electrostatic, relying on the force of attraction between electrical charges present on surfaces;
5. Mechanical interlocking, where the topography of the surfaces allow the adhesive to “key-in” forming a physical bond;
6. Weak boundary or abhesion, where the presence of contaminants on the bonding surface creates a weak bond.

The process used to create an adhesive bond will depend upon the materials to be bonded, the choice of adhesive, method of application (manual or automated), facilities available and the environment in which the adhesive is being applied. What is consistent with every adhesive bond is that the bonding surfaces have to be suitably clear of contamination so the adhesive is able to wet the surfaces, enabling intimate contact to be achieved.

Adhesives may be applied to one or both surfaces in either paste or film form. Manual application can be used for small-to-medium scale components, with various techniques to dispense and spread the adhesive. Automated deposition techniques including spray, printing or dispensing through a syringe nozzle can be used on any size component to reduce assembly times, increase accuracy and improve quality control. Control of the bond line thickness is important to the formation of a successful bond. In applications where this is critical, solid particles or scrims that act as spacers can be formulated into the adhesive to provide optimum thickness and planarity across the bond.

After applying thermosetting adhesives such as epoxies, a curing stage is required. This can be driven by a variety of processes such as the application of temperature and/or pressure, or irradiation with light or microwaves. Thermoplastic adhesives are applied as hot liquids that solidify to form the bond on cooling. On subsequent reheating, the thermoplastic adhesive softens and flows. This can be advantageous where re-work of the joint may be required but would be problematic in applications where the bond may get hot.

Process Advantages

There are numerous advantages and benefits in using adhesives instead of physical joining methods such as nuts and bolts or welding. Being polymeric, adhesives are low mass and can reduce the weight of fabrications (compared to mechanical fastening) and are relatively low cost. Parts can be joined at low temperatures, enabling the assembly of materials such as plastics and composites. Eliminating metal fasteners aids in reducing corrosion and the need for through-holes, which can weaken materials such as composites. The possibility of low

temperature processing and ability to absorb joint stress allows the bonding of dissimilar materials that would otherwise be difficult to achieve.

Adhesives can also be used to provide additional benefits to the formed joint and overall structure. They can be used to fill gaps and form a seal in joints not machined perfectly, they can be used to accommodate and relieve stress in a joint, add toughness, enable thermal dissipation, restrict or allow electrical conduction.

Although care and consideration have to be exercised, the process for forming adhesively bonded joints is relatively straightforward and does not require significant investment in specialised training. Also, unlike welding, many adhesives can be applied in the field with limited or no specialist equipment.

HVM Catapult Capability

Across the centres within the HVM Catapult exists expertise in the formulation, application, and testing of a wide range of adhesive materials as well as the ability to replicate industrial processes and environments. The following table provides a broad outline of capabilities. Please contact us to understand how we can help you to improve your process and deliver efficiencies.

	HVM Catapult Centre			
	AMRC	CPI	NCC	WMG
Surface property characterisation and analysis	x	x	x	x
Surface preparation techniques	x	x	x	x
Adhesive design and formulation		x		
Physical material property characterisation	x	x		x
Material characterisation	x	x		
Mechanical property characterisation	x	x		x
Process development	x	x	x	x
Application specific deposition methods	x	x		
Application specific mechanical testing	x	x	x	
Failure analysis	x	x	x	x
Feasibility and benchmarking studies	x	x	x	
Full-scale prototyping	x		x	
Joint design	x		x	
UKAS accreditation	x			

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Figure 1. Robotic formulation platform enabling automated dispense and mixing of solid and liquid materials enabling screening of formulation spaces.

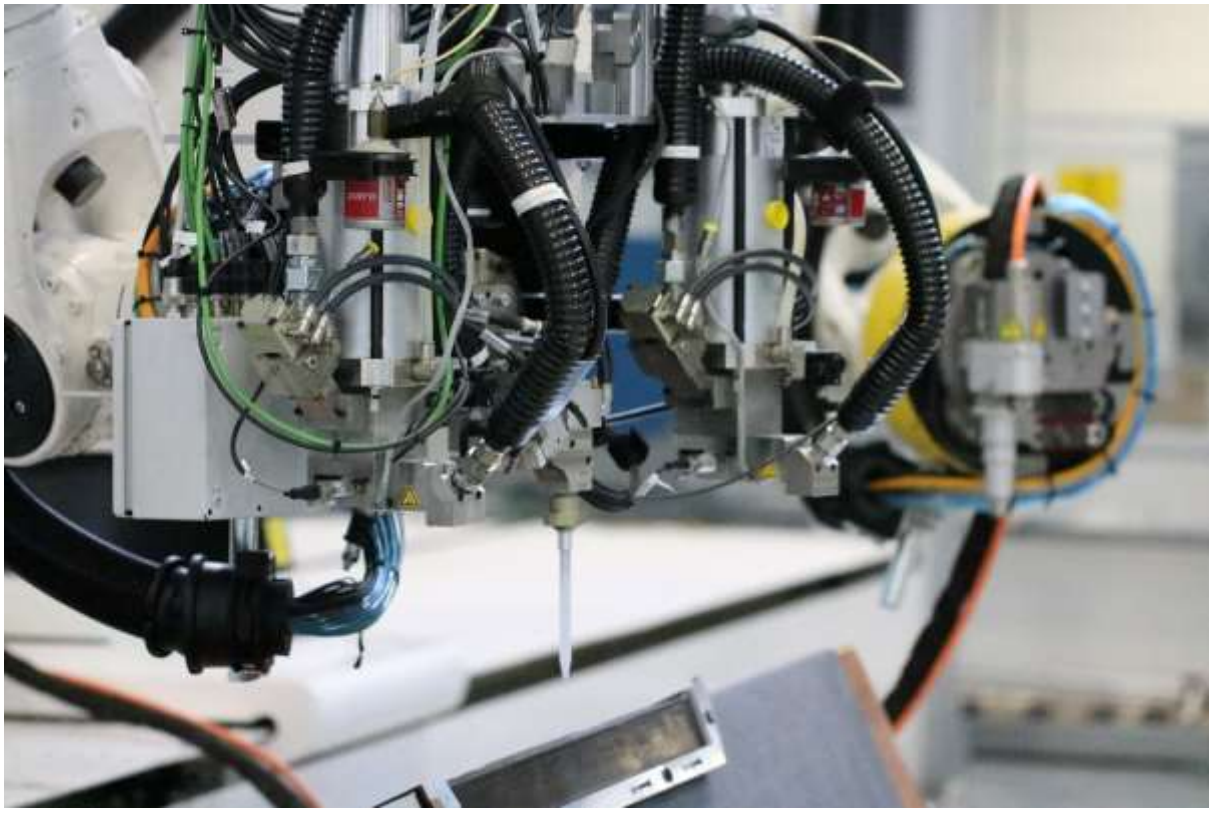

Figure 2 – Automated application of adhesive for repeatable high rate processing

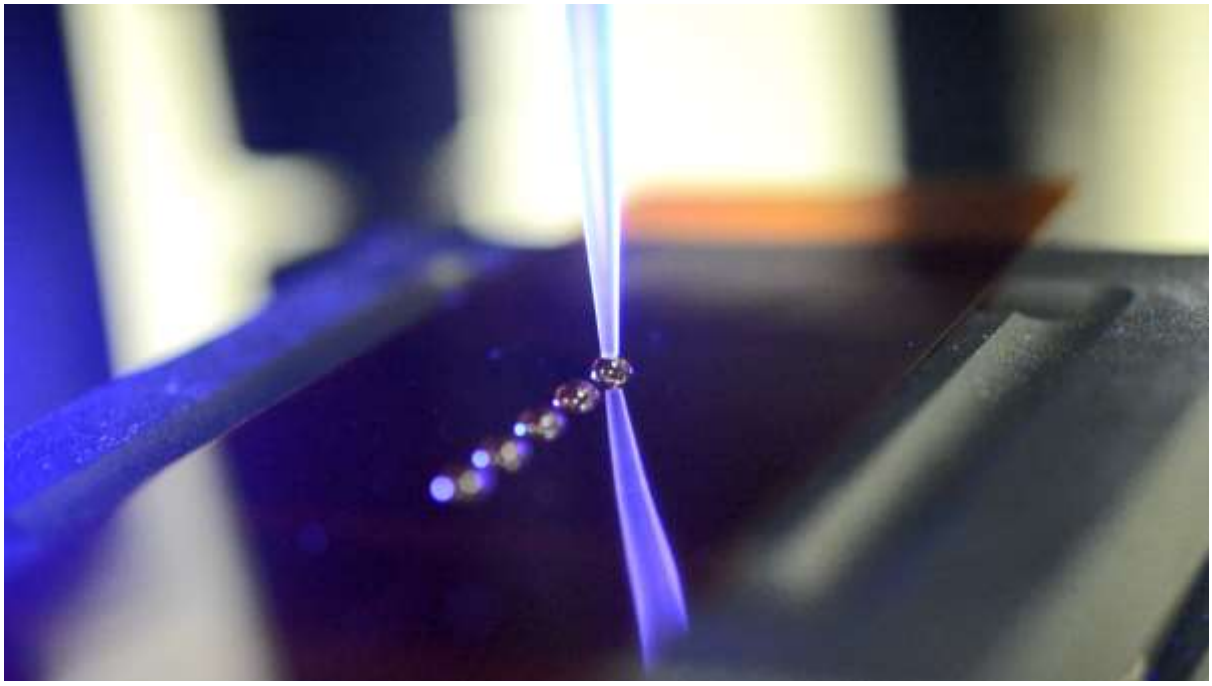

Figure 3 – Drop shape analysis to determine surface energy of substrates for adhesion