

Solvent Bonding of Plastics: Stuck on how to stick it?

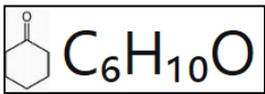




Solvent Bonding of Plastics: Stuck on how to stick it?

No matter the complexity of a medical device, at some point there will be a requirement to secure two components together, whether this be a Luer to PVC Tube or surgical blades to a robot arm. If you are stuck on how to stick it, solvent bonding your medical devices may provide the solution you're looking for. Mi3's product design engineer, Mark Holme, discusses the technicalities of using solvents to bond medical devices.

Medical device assembly requires a strong, repeatable process for the creation of hermetic seals to applicable leak, strength, functional and stability standards. Whilst there are more technically complex options available in UV cured adhesives and ultrasonic welding of components, solvents such as cyclohexanone have been widely accepted amongst the medical device community.



Cyclohexanone is a common solvent used for bonding plastics.

Application of a solvent to a thermoplastic material softens the polymer, and when pressure is applied results in polymer chain inter diffusion of the plastic materials at the bonding junction. When the solvent evaporates this leaves a fully consolidated bond-line. When first considering whether to join your components there are many good reasons to choose solvent bonding, but there are also some important criteria to evaluate before proceeding further:

Why to Join?

- Aesthetically anonymous (clear & smooth finish)
- Inexpensive materials and labour
- Quick Bonding Time (<10 seconds)
- Air and fluid Leak proof joints
- Strong joints (60N<)
- Long clinical history

Sticking Points

- Material compatibilities
- Material degradation
- Toxic & Flammable assembly fumes
- Component cracking
- Repeatable application process.

Material & Solvent Selection

Not all materials react as desired to create solvents bonds – some don't react at all, some are completely destroyed by the chemical reaction that takes place.

The first step in deciding to solvent bond is therefore to check that your materials are compatible with a chosen solvent, and that this combination creates the mechanical properties desired.

Where possible use tried and tested combinations and lean on the existing data to avoid coming unstuck when testing down the line.

Some materials are prone to stress cracking in combination with solvents, which may be a particular concern if also gamma sterilizing the product. Others may result in a change to the raw material mechanical properties before use on the patient.

Base materials can be used dissolved in solvents to increase viscosity and fill gaps.

Application

Solvent bonding is best suited to joints that can be quickly assembled and left untouched before the next assembly process for several minutes without any external forces applied. The hermetic seal desired is heavily dependent on homogenous application of the solvent and selecting the application method can be as important as the solvent selection. There are four common application methods, some being more widely used in bonding medical devices than others:

Solvent Dispenser – Dispensers can precisely control the amount of solvent applied to each surface although they aren't always possible for recessed, tapered or generally awkward geometries. Consistent application from a solvent dispenser can also be reliant on the geometrical stability of components as the dispenser has a fixed geometry.

Brush-On – The solvent is brushed onto the surfaces to be joined. Sufficient pressure is then applied until the full strength bond is formed and the solvent has evaporated,



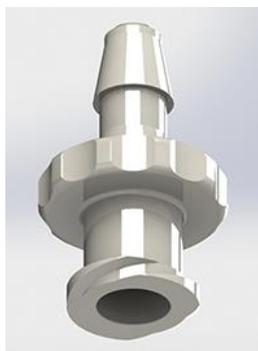
Capillary Action – This is commonly used with acrylic components where a consistent gap between the parts allows for the solvent to flow along the surfaces to be joined.

Dip-Dab – The surface to be joined is dipped into a vat of solvent for a set amount of time. Excess solvent is removed, to avoid marking the material, with a mesh or pad prior to bonding the surfaces together. This is often used for complex components and is seen as an alternative to dispensers since a manual or semi-automated dipping process can be implemented.

Whichever application method is chosen, it is important to ventilate the area and keep solvents away from heat sources, and ensure bonding surfaces are clean and accessible. Review the use of other chemicals that may react with solvent within the production environment creating risk to both assembler and patient.

Component Geometry

As well as restricting application methods, the geometry of a component must be reviewed for the risk of trapping a solvent in voids as materials can be absorbed within minutes if submerged in aggressive solvents.



Solvents generally prefer interference fits on components whereby the entire bonding surfaces are in contact with no gaps, though base material and solvent compositions can be created to fill gaps if required.

Bonding surface area is particularly pertinent for tapered geometries where your anticipated surface can be greatly reduced if the gap between bonding surfaces is too large.

The team at Mi3 can advise you on all aspects of solvent bonding methods and suitable solvents to use with your specific devices.

Look out for other articles in the Mi3 Design & Development White Paper series.

Recommended Thermoplastic & Solvent Compatibility⁽¹⁾:

Thermoplastic	Compatible Solvents
Acrylonitrile Butadiene Styrene (ABS)	Methyl Ethyl Ketone (MEK)
	Methyl Isobutyl Ketone
	Methylene Chloride
Acrylic	Ethylene Dichloride (EDC)
	Methylene Chloride
	Methyl Ethyl Ketone (MEK)
	Vinyl Trichloride
Polycarbonate (PC)	Ethylene Dichloride (EDC)
	Methylene Chloride
	Methyl Ethyl Ketone (MEK)
Polystyrene (PS)	Acetone
	Ethylene Dichloride (EDC)
	Methylene Chloride
	Methyl Ethyl Ketone (MEK)
	Toluene
	Xylene
Polyvinyl Chloride (PVC)	Acetone
	Cyclohexane
	Methyl Ethyl Ketone (MEK)
	Tetrahydrofuran
Polyester	Cyclohexanone
Polybutadiene	Benzene
	Cyclohexane
	Hexane
	Toluene
Polysulfone	Methylene Chloride



References:

1. Yeh, H.J. (2013). "10 Overview of Welding Methods for Medical Plastics". *Joining and Assembly of Medical Materials and Devices*. Elsevier. pp. 291–294.

About the Author:

Mark Holme is a medical product design engineer responsible for introducing new single use medical devices at Mi3, with experience of prototyping, CAD Design, injection moulding, project management and validation activities. Following his MEng Medical Engineering degree at the University of Leeds, Mark has experience with sheet metal design, teaching and medical devices, and is currently working towards CEng status.

About Mi3:

Mi3 are the experts in designing, developing and manufacturing end-to-end advanced medical and surgical solutions – providing specialist knowledge in injection moulding, device assembly & packaging, thermoplastic engineering, tubing systems, and regulatory compliance. We take your product ideas from consultation to concept to production, and work alongside you to bring medical innovations to life.

Visit our website at www.mi-3.co.uk to learn more about our contract manufacturing services or contact us directly by clicking [here](#) to discuss your requirements.