Managing blooming in an adhesives process

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Introduction

Cyanoacrylates (CAs) are a popular adhesive choice for many applications. They are easy to use, single-part adhesives that cure quickly at room temperature, offer good throughput and are suitable for bonding a range of substrates including metals, plastics, elastomers and porous materials. One downside of their fast curing speed is that they are quite volatile, which can cause blooming.

If you have ever used a cyanoacrylate adhesive (often known as “instant adhesive” or “superglue”), you may have seen blooming — a chalky, white residue usually around the edge of the bondline on the surface of your part. Importantly, blooming does not affect the integrity of the adhesive bond, but it will be undesirable if aesthetics are important to you, or if the presence of blooming might imply a quality problem to your customer. If you are making medical devices, jewellery, electronic instrumentation, consumer electronics or loudspeakers, for example, you may understandably be concerned about blooming compromising the appearance of your products.

Figure 1 – Example of blooming or frosting formed on an exposed fillet of cyanoacrylate adhesive

Why Does it Occur?

CAs cure very rapidly, usually by exposure to the moisture on the surface of the parts. They achieve fixture strength in seconds and full cure in up to 24 hours. The chemistry tends to be quite volatile, and blooming is a side effect of this volatility and fast cure. The energy from the cure chemical reaction can promote the release of unreacted cyanoacrylate monomers into the air, which condense and fall back onto the surface of the part in the form of white crystals or flakes. The resulting hazy by-product, most noticeable around the periphery of the bondline, is known as blooming, frosting or blushing.

Low odour, low bloom cyanoacrylate adhesives
There are a number of cyanoacrylate monomers which are used to formulate cyanoacrylate adhesives. Ethyl (ECA) monomers are the most commonly used in both industry and consumer products; they are effective and cure quickly. Their volatility means that they also more prone to both blooming effects and a harsh odour, which may be irritating and require local ventilation during use.

Cyanoacrylate adhesives based on methoxyethyl (MECA) monomers are less volatile than ECA products, and are often marketed as “low odour, low bloom” formulations. They are less susceptible to blooming and have a more acceptable smell. However, they can compare poorly with ECA-based products in terms of cure speed, strength and cost, and so their use involves compromises.

More recent advances in MECA-based cyanoacrylate adhesives have enabled the production of products which are low odour and low blooming without compromising cure time or physical performance. For example, the **Born2Bond Ultra** range of cyanoacrylate adhesives combine the fast cure associated with ECA-based CAs with the low blooming characteristics of MECA-based CAs. Their inherently low volatility means less odour, and they are less irritating; there are no CLP hazard symbols on the labels.

Figure 2 – Born2Bond Ultra is available in low, medium, and high viscosities

Process
Another way of reducing blooming is to minimise the size of adhesive fillets. Dispensing cyanoacrylate adhesives is often a challenge because of their fast reaction time, but it is worth optimising for two reasons. In general, cyanoacrylate adhesives are more effective when used sparingly – cure is faster, bonds are stronger and there is material economy. They are also optimal when the bond is completely interfacial – between two surfaces – as the cure is a surface reaction. Excess adhesive squeezed out into fillets around the bondline will cure more slowly and will provide exposed surfaces from which blooming can occur, so eliminating or reducing this will help with a blooming issue. Where joint size or configuration means that fillets are inescapable, a low bloom, fast cure formulation allows manufacturers a wider dispensing tolerance.

Cure Speed

A number of factors can influence the cure speed of cyanoacrylate adhesives, beyond the inherent reaction time of the formulation. In general terms, slowing down the cure will allow more time for volatile monomers to be released. On the other hand, making the cure a lot faster will generate a higher exotherm (heat energy) in the adhesive, encouraging the release of volatiles. Controlling the speed of cure is one potential way of minimising blooming.

If exposed fillets are an inevitable outcome of the bondline design, then accelerating their cure should restrict the opportunity for blooming. One method is to use an activator - a chemical, usually applied by spray, which quickens the cure. Application might need to be carefully controlled, as there is a risk that this chemical reaction is too fast, creating an exotherm which drives off unreacted monomers to give frosting or blooming. Another, possibly more elegant, approach is to use a light cure cyanoacrylate adhesive, like **Born2Bond Light Lock**. Any interfacial adhesive is cured by the normal cyanoacrylate mechanism, but exposed fillets are cured tack-free by exposure to low intensity UV light. The light cure of only a few seconds eliminates the possibility of blooming because the volatiles never have a chance to become mobile. It is suitable for use in assembling medical devices, since it passes ISO 10993 testing. These light cure CAs can replace an activator in a bonding process, removing a chemical and the associated health & safety, environmental and cost overhead.

Figure 3 – A low powered UV torch can be used to cure exposed fillets of Born2Bond Light Lock cyanoacrylate adhesive.

Cyanoacrylate adhesives will become slower with age, and so more prone to blooming. Practice good stock control and housekeeping to preclude the use of materials which are out of shelf life.

Environmental Factors

Simple local ventilation and increased airflow will help to blow the volatilised monomers away from the parts before they can settle on the surface. Blooming will also occur if the bonded parts are placed too quickly into a sealed environment such as a bag or shipping container, where any volatility is trapped with the parts. Because CAs usually cure by a

reaction with surface moisture, relative humidity (RH) can be important. If RH is too low, the adhesive will take longer to cure. If it is too high, the curing reaction may occur too quickly and the resultant larger exotherm may encourage blooming. Monitoring of relative humidity is advised for critical processes involving moisture-related cures (single part RTV silicone is another example where RH is important). Higher ambient temperatures encourage the volatility of the CA monomers, leading to a higher likelihood of blooming. Conversely, lower temperatures slow the reaction mechanism, causing prolonged cure time and opportunity for volatiles to be released into the air. Best practice would suggest keeping the relative humidity to 40% - 60% and the temperature at around 21ºC; consistency of environmental conditions will inform consistency of process times and outcomes.

Substrates

Acidic surfaces like wood or leather will cause cyanoacrylate adhesives to cure more slowly, increasing the risk of blooming. In these cases, it is recommended that a “surface insensitive” CA is used. They have additives which neutralise the acid surface and promote cure. Alternatively, **Born2Bond Ultra** offers a fixture time on leather of 5-10 seconds, with a low odour, low bloom formulation.

Conclusion

If cyanoacrylate adhesive blooming is an issue, consider changing to one of the latest innovative technologies, which can alleviate the problem without conceding adhesive performance. Low odour, low bloom CAs are now available which are fast cure or offer an additional light cure property. Dispensing and environmental control are also important to help get consistent results. Manufacturers who have previously avoided CAs due to their downsides may be able to benefit from these new options, and manufacturers who have struggled to manage blooming may finally have a solution.

References

1) “Working towards a bloom free manufacturing process”, Polivio Goncalves, *Design Products & Applications*, September 2020

Picture credits

Figure 2 - Bostik

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