Episode Book

EPISODE #5704

Superglue: One Drop, Two Reactions, Five Mistakes

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SYNOPSIS

Superglue looks like the simple adhesive: one part, no mixing, seconds to set. But underneath that five-dollar tube is a two-part reaction where the second part is the moisture already on your surface — and that paradox explains almost every failed repair you've ever attempted. This episode digs into the cyanoacrylate family, from Harry Coover's twice-discovered lab accident at Kodak to the anionic polymerization that fires the bond, and walks through the five mistakes that break the joint: too much glue, releasing too soon, contaminated surfaces, the wrong plastic, and gaps. There's also a listener question about a broken plastic ring that may never have been fixable at all. If you've ever stared at two halves of something and been certain you knew the trick, this one's for you.

TRANSCRIPT



Corn

The ring is in two pieces on the counter. And you know superglue can do this. You've done it before — you're almost sure you've done it before — and now the two halves are just sitting there and you cannot remember what the trick was.



Herman

The trick being... there was a trick.



Corn

Which is the whole problem. Daniel wrote in this week — and he opens with exactly that scene, the broken plastic ring, the absolute certainty that the glue works, the complete blank on how you made it work last time. And he's honest about where the question comes from. He says if you'd told him a year ago that there were things worth knowing about applying adhesive tape, he'd have laughed. Then we did the VHB episode, and it turned out technique was the entire story. So he wants the same treatment for superglue. His words: it may not be the most ideal adhesive, but it's significantly less complicated than epoxy. So — what is it chemically, what do people commonly get wrong, what do you actually need to know about how it bonds to get it right, and why do the small details matter so much when the product is a five-dollar tube you've been using since you were nine?



Herman

He's not wrong about the last part. A five-dollar tube you've been using since you were nine, and you've been using it wrong for most of that time.



Corn

So let's start with what's actually in the tube.



Herman

What's in the tube is a family, not a brand. "Super Glue" is a trademark that became a generic, the way people say Kleenex. The chemistry underneath is cyanoacrylates — esters of cyanoacrylic acid. The classic one is ethyl 2-cyanoacrylate, that's your Krazy Glue, your original Super Glue. But there's also methyl 2-cyanoacrylate, and then the longer-chain



Herman (continued)

ones — n-butyl, octyl, 2-octyl — which are what you find in medical adhesives and the nicer workshop products, because the longer the alkyl chain, the more flexible and less brittle the cured polymer.



Corn

And it was found twice.



Herman

Twice, by the same man, and he didn't want it either time. Harry Coover at Kodak, in the early forties, working on clear plastics for gun sights. His team made cyanoacrylate and it was a disaster — it stuck to everything, ruined the equipment, they threw it out. Then in 1951, years later, he's running a different project, and a student — some accounts say it was one of his chemists — puts an ethyl cyanoacrylate sample between two refractometer prisms to measure its refractive index, and the prisms are fused together. Permanently. And Coover's the one who realizes what they're looking at.



Corn

Nine years apart, same substance, first time it's a lab accident, second time it's an invention.



Herman

That gap is the whole story of the product, honestly. And then Loctite starts selling it as an adhesive in the sixties, and it becomes the thing in your kitchen drawer.



Corn

So the framing for today — and I want to get this right, because it's the thing Daniel's poking at. Superglue is simpler than epoxy. One part, no mixing, seconds to set. That sounds like less to know, not more.



Herman

It's less to mix. It is not less to know. Epoxy forgives you — you can slop it into a gap, it cures over hours, you can reposition, it fills. Superglue is doing something completely different and it punishes you instantly for not understanding it. It's a one-part adhesive with a two-part reaction, and the second part is the moisture on your surface.



Corn

So that's the chemistry. Mechanism, then mistakes.



Herman

Cyanoacrylate cures by anionic polymerization. Not drying, not oxidation, not a hardener you add. It's a chain reaction that gets kicked off by a nucleophile — and in practice, that's hydroxide ions, which means trace water on the surface. The molecule has two electron-withdrawing groups hanging off it: a cyano group and an ester group. Both of them pull electron density away from the carbon-carbon double bond, which makes that double bond desperate for a nucleophile to attack it. And then once the attack happens, the resulting anion is stabilized by those same two groups, so it stays reactive and grabs the next monomer, and the next, and the next. It's a cascade.



Corn

And it propagates through the whole puddle in seconds.



Herman

Seconds. There's a 2025 density functional theory study that modeled ethyl cyanoacrylate on copper, silica, and gold surfaces specifically to nail down this moisture-driven anionic curing, and that's the mechanism it confirms. Trace water is the trigger.



Corn

Here's where it stops being intuitive. Water starts the reaction. Water also stops it.



Herman

Both. And that's the moisture paradox at the center of the whole craft. You need water to initiate, and water — along with air, and acidic protons generally — terminates the chain. Weak acids slow polymerization down, strong acids stop it dead. So the entire technique of using superglue well is managing a tiny, controlled amount of moisture. Not eliminating it, which is what most people assume "clean surface" means. You're not trying to get the water off. You're trying to get it down to the right amount, distributed evenly.



Corn

And that's why breathing on the joint works.



Herman

Breathing on the joint is the cheapest accelerator in existence. Your breath is warm and saturated with water vapor, and you're delivering it exactly where you want the reaction to start. And here's the part that annoys me every time I think about it — the active ingredient in a can of commercial activator spray is essentially water. You're paying eight dollars for a can of the thing you exhale for free.



Corn

With some solvent in it so it flashes off, which is why it feels like a magic spray.



Herman

Right, it delivers water in a carrier that evaporates and doesn't leave the joint wet. But the chemistry that does the triggering is water. I've seen people recommend a plain spray bottle of tap water and honestly... it works.



Corn

And the acid stabilizers in the bottle — that's why the tube doesn't cure itself in storage. The glue ships acidic on purpose so it can't start polymerizing until it meets your work surface.



Herman

That's the whole design. Add acid to hold it inert, and let the moisture on the surface neutralize the acid locally and fire the reaction there.



Corn

Now, the failure modes, because this is where the broken plastic ring lives. What do people actually do wrong?



Herman

Number one, and it's not close: too much glue. People squeeze a bead down the crack like they're caulking a bathtub. Cyanoacrylate works by capillarity — you want it drawn into a thin joint by surface tension, not sitting in a puddle on top of it. A thick layer actually cures more slowly and forms a weaker, more brittle bond than a thin one, because the reaction generates heat and the polymer structure ends up worse. The recommendation from the precision-tip crowd is roughly one drop per square inch of bond area.



Corn

One drop per square inch, and watch somebody repair a mug. They put an entire tube's worth of glue on the rim.



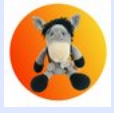
Herman

And then they hold it for four seconds and put it down. Which is mistake number two — the set time is not the handling time.



Corn

Say more about that, because this is the one that catches everybody.



Herman

Superglue sets in ten to forty-five seconds in a good joint, and that's the initial grab — that's where the bond is green. But you still need to hold or clamp for a few minutes. And the failure is subtle: somebody holds it for thirty seconds, feels it stick, sets it on the shelf,



Herman (continued)

and the parts shift a few thousandths of an inch while the polymerization is still finishing. And now the bond has locked in with a misalignment, and it's a bad joint. The glue isn't weak. You moved it.



Corn

Number three is surfaces.



Herman

Oil, silicone, wax, dust, skin oils — anything that prevents wetting. If the glue beads up on the surface instead of spreading and wicking, it can't get into the joint and it can't find the moisture that's in the substrate. Wipe with isopropyl alcohol, let it dry. Which people hear as "make it dry" and they're not wrong, they just misunderstand why. You're drying off the contaminant, not the water that's part of the reaction.



Corn

Number four is the wrong material. And I think this is the plastic ring.



Herman

It's a very strong candidate. Cyanoacrylate does not bond low-surface-energy plastics — polyethylene, polypropylene — without a primer or some kind of surface treatment. Those materials have almost no surface polarity, so the glue has nothing to grab. And "some kind of plastic ring" is very often exactly one of those two, because they're cheap, they're everywhere, and they don't look any different from a plastic that would bond beautifully.



Corn

Which explains the "I've definitely done this before and it's not working now" feeling. Same glue, same technique, different plastic.



Herman

Same glue, same technique, different plastic, and no way to tell by looking at them. That's the cruel part.



Corn

Number five.



Herman

Gaps. Cyanoacrylate is for tight-fitting parts. If the two pieces don't mate up flush, cyanoacrylate is the wrong tool, because it has no body — it's a thin liquid that wants to be a film, not a filler. If you've got a gap you want two-part epoxy. And I keep coming back to a line from a workshop practitioner in a Hacker News thread on this — the blunt version: if there's a gap or you're trying to fill space, superglue is the wrong tool for the job, you want two-part epoxy. They put epoxy next to superglue at the hardware store for a reason.



Corn

That's the line for the episode. Now — the ring. The ring isn't just a material problem, is it?



Herman

No, the ring is a joint design problem on top of everything else. A ring is a closed loop under flex. It's not a static lap joint, it's a structure that gets loaded in peel and flex every time anything pulls on it. And cyanoacrylate is rigid and brittle in the cured state — it has almost no give. So you get a joint that's stiff in a place that needs to move, and it's being asked to hold on a material that may not want to bond at all. That's two independent reasons to fail before you even start.



Corn

So Daniel's ring might just... not be fixable with the glue. Regardless of him remembering the trick.



Herman

The trick might be that there was never a trick that was going to work for this ring. He might be remembering a different ring.



Corn

Right. And there's the reframe that makes this the VHB thesis again. If the joint is separating, the diagnosis is technique or joint design. Not the glue.



Herman

That's the frame, and it's exactly right. Glue bonds are stronger than the materials they're joining, in a properly designed joint. The material fails before the glue does. If your glue line is the thing that's opening up, the glue line was the wrong solution for that joint, or it was applied wrong. It's diagnostic, not fatalistic.



Corn

So that's the chemistry, that's the failure pattern. What actually works, and how does this compare to the other adhesives?



Herman

Technique first. Viscosity matching, surface prep, joint design. On viscosity — thin cyanoacrylate is water-like, it's for tight joints and it wicks into cracks by capillary action. That's the one you want for a hairline crack where the two halves still fit together. Medium and thick are for gaps and filling, and those are the ones with additives in them that give the polymer some body. Buying one bottle and using it for everything is like owning one wrench.



Corn

What's the actual prep procedure?



Herman

Clean with isopropyl alcohol. Lightly abrade if it's plastic or metal — 120 to 220 grit, just enough to give a texture and remove any glaze or oxidation. Then make sure it's dry, clamp it properly, and give it the full time.



Corn

Now — baking soda. Because this one splits the room.



Herman

It absolutely does. Here's the mechanism, because it's real chemistry. The glue contains acid stabilizers to keep it liquid. Sodium bicarbonate is a mild alkali. So you apply the glue, you sprinkle baking soda on it, and the bicarbonate neutralizes the acid locally, which fires the polymerization almost instantly — and the soda powder becomes a physical filler in the matrix, so you get this hard, sandable, drillable plug you can file and paint.



Corn

That sounds useful.



Herman

It is, in the right spot. If you've got a stripped screw hole and you want to build up material you can redrill, it works. But there's a real disagreement about whether it makes the bond stronger, and the workshop practitioners say no. The consumer guides sell it as a strength booster. The people who do this for a living say it's a last resort for filling, and if you need actual structural strength across a gap you should be using epoxy, not superglue plus a kitchen ingredient. And you have to build it up in thin layers, because that reaction is exothermic. Layer it thick and it gets hot.



Corn

Which brings up the thing I did not know about, and it's the reason you never leave a tube of superglue sitting on a cotton cloth.



Herman

Cyanoacrylate plus cotton or cellulose is violent. Cotton is covered in hydroxyl groups, and hydroxyl groups are exactly the nucleophile that initiates polymerization. So the glue doesn't just cure against cotton, it cures explosively fast, and the reaction throws off enough heat that the cotton can actually ignite. There are plenty of shop fires that start exactly this way. Nobody expects it because glue isn't supposed to be a fire hazard.



Corn

And acetone gets it off your fingers.



Herman

Acetone — nail polish remover — dissolves cured cyanoacrylate. That's the joke that turns into a real fact. You didn't glue your fingers together permanently, you just haven't gone for the nail polish remover yet.



Corn

Now compare. Cyanoacrylate versus epoxy, straight up.



Herman

Superglue is fast — seconds — but it's brittle, it's poor at gap filling, and it's poor under peel and impact. Epoxy is slow — minutes to hours — but it's stronger in tension, it fills gaps, and it tolerates flexing far better. The strongest single-component adhesives are heat-cure epoxies, and those run thirty-five to forty-one newtons per square millimeter.



Corn

Put that in pounds.



Herman

Five thousand one hundred to six thousand psi. Epoxy is also waterproof once cured, and so is superglue — that surprises people. It's not water that kills the bond over the short term, it's the temperature and the time.



Corn

And versus VHB.



Herman

Different geometry entirely. VHB is a closed-cell acrylic foam — it's a thick, conformable layer that spreads load and handles uneven surfaces. It's excellent in shear. Cyanoacrylate is a rigid, thin-bond-line adhesive; it needs the surfaces to match. The choice comes down to whether the load is shear or peel, and whether the surfaces are smooth and close-fitting. VHB can handle a surface that isn't flat. Cyanoacrylate cannot.



Corn

And there are hybrids now.



Herman

There are. There's a class called structural instant adhesives — cyanoacrylate-epoxy hybrids — that are trying to give you the CA set speed with epoxy-ish strength and humidity resistance. They've been in the trade press for a decade now.



Corn

Now the durability thing, because this is the one I want on the table. Superglue feels permanent.



Herman

It feels permanent and it isn't. This is the part the DIY literature basically ignores. Orthodontic researchers use cyanoacrylate as a bracket adhesive, which means they've measured precisely how it degrades under conditions that mimic a mouth, and the numbers are grim. One study took the adhesive through five hundred thermocycles between five and fifty-five degrees Celsius — that's just hot and cold, over and over — and the shear bond strength dropped by about eighty percent.



Corn

Eighty percent.



Herman

And a separate study stored the bonds in water at body temperature and measured them at twenty-four hours and then at thirty days. Seven point one megapascals at a day. Two point seven megapascals at thirty days. Fifty percent gone in a month, in water, at thirty-seven degrees.



Corn

So a superglue repair that feels rock solid in October can be a fraction of that strength by spring.



Herman

Quietly. There's no visible failure. The bond just isn't what it was. Heat cycling and moisture ingress — there's a 2024 electrochemistry paper that uses impedance to track exactly that, moisture working into the joint over time.



Corn

Also thin is better — there's a number for that.



Herman

There is. A 2021 lap-joint study on 3D-printed parts found the optimal bond line was about 0.2 millimeters, and it outperformed 0.3 and 0.4. Thinner beat thicker. Which is the same finding as the "one drop" advice, arrived at from the other direction.



Corn

And then the flexing problem, which is the ring again.



Herman

The ring is a joint that's being asked to flex, in a material that may not accept the glue, with a hardened adhesive that has no give. If the diagnosis is joint design, then the answer for the ring isn't a better technique — it's a different joint. A mechanical fix. A dowel, a screw, a pin, or a replacement ring.



Corn

Which is, the useful thing to take away.



Herman

There's also a nice piece of medical data that runs the opposite direction, and I like it because it shows the material isn't just fragile. Formulating the cyanoacrylate with longer chains — 2-octyl and n-butyl — improved adhesion to skin up to eight times, and catheter securement by more than seven times. Same chemistry, different ester, dramatically different performance. Which is a good reminder that "superglue" isn't one substance.



Corn

So which ester do I want at the hardware store?



Herman

For a rigid joint that needs speed, the standard ethyl is fine. For something that flexes, or bonds to skin or a soft plastic, look for the octyl or butyl formulations. They're more expensive and they're better at the jobs the cheap one fails at.



Hilbert

Two hundred and forty dollars.



Corn

What?



Hilbert

That's what a one-ounce bottle of the medical-grade octyl cost in the early two thousands. Two hundred and forty dollars, from a surgical supply house. I priced it because I wanted to build a repair kit — a little box for the shop with the good stuff in it instead of the tubes that go hard on the shelf.



Herman

Did you get it?



Hilbert

I got the dollar-forty tube from the hardware store. And it worked, most of the time. The thing nobody tells you about the cheap tubes is that once you open one, you've got maybe a month before the moisture in the air has cured the top of it solid. So the whole industry is quietly built on the fact that you buy a tube, use a quarter of it, and throw the rest away. Somebody did the math on that a very long time ago and decided it was fine.



Corn

That's the design.



Hilbert

But the technique thing, the clamping — the way I learned it was from a man named Wes, who ran a model shop. He had a trick where instead of clamping, he'd seat the parts and then put a single drop on a toothpick and just touch it to the edge of the joint, and let capillary action pull it in. No squeeze-out, no wiping, no bead to clean off. He said the glue finds the seam if you let it. It was the whole thing he had, honestly, and it took me years to appreciate.



Herman

That's the one-drop rule, but as a technique. He's using capillarity as the applicator, not as an afterthought.



Hilbert

And it's the only way you can bond something where a clamp won't reach. He used it on wing struts on a model plane he built for a kid. It took him four nights, and I watched him do two of them, and I still think about that toothpick.



Corn

Huh.



Herman

Four nights of toothpicks.



Hilbert

Four nights. But nobody ever wrote a guide about it, because it's not a product. It's just how a man did the work.



Corn

So here's where I land on the ring. The temptation is to think the failure is about how much force you applied, or how long you held it, or which brand you bought. And it's not.



Herman

None of those. It's whether the material will accept the bond at all, whether the joint geometry can be held by a rigid adhesive, and whether the moisture on the surface is the right amount in the right place.



Corn

The tube is five dollars and the knowledge is the expensive part.



Herman

Which is exactly the VHB lesson, and Daniel basically said so. The premise of "there's a technique to adhesive tape" sounded ridiculous until it turned out to be the whole thing.



Corn

Cutting-room floor. Something from the research that didn't fit.



Herman

This one I like. Loctite didn't start selling cyanoacrylate as an adhesive until the sixties, but there was a window in between where the only commercial use anyone had found for the stuff was... closing wounds. Field medics in Vietnam were issued spray cans of it. That's why the medical-grade formulations exist as a separate product category. The glue was a battlefield tool before it was a hardware-store item.



Corn

Before it was a thing that sits in your junk drawer next to the dead batteries.



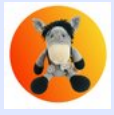
Herman

Somebody decided a substance that fuses refractometer prisms was better suited to sealing a soldier's wound than to fixing a mug.



Corn

And the mug is what we use it for.



Herman

Where it's mostly wrong, if we're honest.



Corn

The open question, then. Why does something this simple fail this often?



Herman

Because "simple" described the wrong thing. The product is simple — one part, one tube, no mixing. The chemistry is not simple, and the technique is not simple, and there's no feedback loop that teaches you. You don't get an error message. You just get a joint that opened up six weeks later.



Corn

Which means the lesson from Daniel's ring probably isn't "use more glue" or "try again harder." It's that if you understand what the tool is actually doing when it works, you know when it can't. That's the whole thing, really — a joint that fails isn't a failure of effort, it's information.



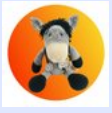
Herman

What information it gives you is worth more than the ring.



Corn

That's the show. Behind the desk as ever, keeping the whole thing running, our producer Hilbert Flumingtop.



Herman

This has been My Weird Prompts.



Corn

If you got something out of this one, leave us a review and subscribe — it helps people find the show. We'll be back soon.



Herman

See you then.