CA FINISH - HOW IT WORKS

Michael Dresdner

The following pages are several exchanges between myself, Gordon Patnude, and renowned finishing expert and good friend Michael Dresdner, on the subject of using BLO and CA for finishing pens. These took place over a couple of years, most recently last month as I was looking for a more complete explanation of the CA finish.

On Tue, Dec 8, 2015 at 3:04 PM, GORDON PATNUDE <gppatnude@comcast.net> wrote:

Michael:

A few months ago I read several different articles about finishing pens using boiled linseed oil [BLO] and CA glue [medium]. I found them at the International Association of Pen Turners [IAP] and Woodturning Online websites <<http://www.woodturningonline.com/index.php >> .

After digesting these for a week or more, and being frustrated and unsatisfied with the results I was getting with the standard friction finishes available and some that were suggested to me by members of Silicon Valley Woodturners, [the turning group I belong to, here in San Jose] I did some experimenting and to my great surprise, got very satisfying results.

I have been using it now for about 3 months [only on wood pens or stabilized wood and not on plastics/acryilics].

What I do not understand, though, is what is the chemistry that occurs between the CA and the BLO. Is the BLO some kind of catalyst. I do not feel any heat during the process, except from the friction of the paper towel I am using as an applicator.

--

Michael wrote in response:

Catalyst is not actually the right word, but you are on the right track.

A catalyst is something that accelerates a chemical reaction without taking part in it. Japan driers are a catalyst -- they speed up the oxygen cure, but do not change the final molecule being formed by the polymerizing oil.

Cyanoacrylate [CA] and linseed oil are reactants, meaning the two chemicals, when they come together, go through a chemical reaction that creates an entirely different molecule than either the oil or the cyanoacrylate would by themselves.

In chemical terms, they crosslink in the same way as the two components of an epoxy crosslink.

The result is a very durable finish with high cross-link density that cures in seconds.

In case you are interested, that finish was actually pioneered by someone fairly local who called me the first time he did it (somewhat by accident) to ask what was happening. It was the late Stephen Blenk from Sequim. He was sadly killed many years ago in a car accident, but was a wonderful and inventive turner and a fascinating guy.

Rereading your question, I realized I may have missed a couple things you were asking.

Yes, the reaction creates heat, but such a small amount that you would not notice it unless you cured a very large amount of oil with a very large amount of cyanoacrylate.

Did you need the exact curing mechanism; that is to say, the chemistry that is taking place at a molecular level?

The short answer is that the mixture makes available hydroxyl groups, oxygen, and double carbon bonds, the actual site of bonding. The conjugated double carbon bonds on the oil open up and react with available carbon, oxygen, or hydroxyl group bonds in the cyanoacrylate (along with hydroxyl groups from moisture in the air) to form three types of bonds, pretty much randomly; carbon bonds, ether bonds, and peroxide bonds, all of which are quite strong. There is some evidence that over large periods of time the later two tend to reduce to carbon bonds. These are all legitimate covalent bonds, not the weaker hydrogen bonding or van der waals forces found in some other adhesives and coatings.

Does that help?

--

Michael Dresdner
www.rainydayukes.com
"You can never stay sad while playing a uke."

On Sun, Jul 2, 2017 at 4:45 PM, GORDON PATNUDE <gppatnude@comcast.net> wrote:

I have been making pens now for a while now and for the last few years my "go-to" finish" is BLO [boiled linseed oil] and CA glue.

With the pen spinning on the lathe at about 1500rpm I use a densely folded paper towel and put a couple drops of BLO on it, wipe it on the pen, followed closely by medium CA dribbled onto the paper towel while moving from one end of the pen to the other.

Then I continue to move the padded paper towel back and forth for as long as it takes for the CA to completely dry. The paper towel gets warm/hot and ends up hard and shaped half around the pen.

I repeat this at least 4 times, sometimes up to 9 or 10, until the finish is smooth and has developed a glossy appearance.

What I am curious about is this: Am I really building the finish or am I just wasting time, paper towels, BLO and CA??

I don't have any way to determine if the finish is actual building, so how can I tell??

On 7/3/2017 7:50 AM, Michael Dresdner wrote:

Gordon:

Yes, you are really building a finish, though considering how tough it is, you might consider stopping after one or two applications.

Cyanoacrylate is a reactive chemical for boiled linseed oil. In other words, it causes the oil to immediately crosslink, something it will do by itself in the presence of oxygen over one or two days. You're just making it happen way faster.

Once you have one or two coats of crosslinked oil, you have a good bit of protection. The only reason to add more coats is to build up a thicker coat to get the appearance of more depth or gloss.

Whether you choose one coat or many, what you are doing is just fine and not a waste of time. It's also making a very durable finish.

On Tue, Jul 4, 2017 at 2:43 PM, GORDON PATNUDE <gppatnude@comcast.net> wrote:

Michael:

To further the discussion on CA/BLO, if I understand your explanation, it is not the CA but the BLO that is building and becoming thicker and stronger. What happens to the CA in this reaction??

On 7/4/2017 3:00 PM, Michael Dresdner wrote:

The CA becomes part of the new molecule formed.

Normally, when oil cures it takes oxygen from the air, forming peroxide and ether bonds at all the sites on the fatty acid chains where double carbon bonds exist.

That forms highly cross-linked but somewhat flexible molecular structures that are much larger than what is originally in the oil. In that way, the oil goes from liquid to solid -- the larger the molecule, the more a liquid starts to act like a solid. Thus, it is this combining to form new, larger molecules that creates a film finish.

In this case, the CA forms bonds at those same sites, linking various fatty acid chains, but with different bonding moieties. The result is a faster cure and a more brittle (harder) film.

Bottom line: the CA becomes part of the new molecule formed by the reaction of oil to CA.

On Tue, Jul 4, 2017 at 3:11 PM, GORDON PATNUDE <gppatnude@comcast.net> wrote:

> **WOW!!**
>
> Your explanation is so clear and complete!! I think I understand now.
>
> You should be a teacher

On 7/4/2017 4:44 PM, Michael Dresdner wrote:

Thanks. I was a teacher -- remember? Roger Goad and I had a woodworking school together in Sumner, and I spent more than 20 years on the woodworking show lecture circuit.

I've always found that it is easy to explain something clearly if you truly understand it yourself.

I find that when explanations are fuzzy, it generally means the person teaching does not have as deep an understanding of the subject. In some cases, they know only what they've recently been told and are really just passing on a conclusion rather than truly understanding all the ramifications.

To distill something down into a simple statement requires a full understanding of the depth of that subject. That's why people like Carl Sagan and Neil deGrasse Tyson are able to create such clear, simple explanations about very complex issues.

In my case, I have no desire to force finishers to understand all the molecular chemistry that makes their finishes happen, but it is imperative that I understand it in order to give truly valid answers. Obviously, it also helps in the rare cases when someone, like you, asks for a more in depth explanation of why that happens.

On Tue, Jul 11, 2017 at 12:21 PM, GORDON PATNUDE <gppatnude@comcast.net> wrote:

I have been limiting the number of applications of BLO/CA [on my pens for the troops] to 4 and they are looking really good.
I used it again a few minutes ago [2 applications] on a piece of Osage Orange which is a handle on a 1/4" round skew I have made. OMG.....it looks fabulous.

My questions are:

1. Does ambient temperature play any role in BLO/CA reaction process??

2. Is the resulting finish considered and acrylic finish or is it more BLO??

****

I hope all is well with you, Janie and Drew, Katie, et al.

Your friend and avid finishing mentee,

Gordon

On 7/11/2017 2:13 PM, Michael Dresdner wrote:

ANSWERS:

1. Does ambient temperature play any role in BLO/CA reaction process??

Yes, but not much. Basically, almost all chemical reactions tend to double in speed with every 10 degree Centigrade rise in temperature (that's about 18°F), so yes, if you tracked the reaction at two temperatures that far apart, and timed it, you'd probably notice a difference. However, the CA reaction is so fast that even if you halved or doubled it, the speed change would still be insignificant.

2. Is the resulting finish considered and acrylic finish or is it more BLO??

Considered by whom? I doubt anyone who uses these finishes cares about naming them, but if they did, they'd probably call it a "cyanoacrylate and oil finish."

Understand that there is no consistent naming gestalt* when it comes to finishes. For example, some are defined by the final molecule (polyurea), some by the initial molecule (shellac), some by a minor ingredient (waterbased), some by their durability (rock hard varnish), some by use (spar varnish), some by sheen (matte or dead flat finish), some by pure whimsy.

***gestalt** Noun: (gestalten) gu’stalt or gu’shtalt

A configuration or pattern of elements so unified as a whole that it cannot be described merely as a sum of its parts

Linseed oil

From Wikipedia, the free encyclopedia

The **lead section of this article may need to be rewritten.** Please discuss this issue on the article's talk page. Use the lead layout guide to ensure the section follows Wikipedia's norms and to be inclusive of all essential details. *(March 2016) (Learn how and when to remove this template message)*

Linseed oil, also known as **flaxseed oil** or **flax oil**, is a colourless to yellowish oil obtained from the dried, ripened seeds of the flax plant (*Linum usitatissimum*). The oil is obtained by pressing, sometimes followed by solvent extraction. Linseed oil is a *drying oil*, meaning it can polymerize into a solid form. Due to its polymer-forming properties, linseed oil can be used on its own or blended with combinations of other oils, resins or solvents as an impregnator, drying oil finish or varnish in wood finishing, as a pigment binder in oil paints, as a plasticizer and hardener in putty, and in the manufacture of linoleum. Linseed oil use has declined over the past several decades with increased availability of synthetic alkyd resins—which function similarly but resist yellowing.[1]

Linseed oil is an edible oil in demand as a nutritional supplement, as a source of α-Linolenic acid, (an omega-3 fatty acid). In parts of Europe, it is traditionally eaten with potatoes and quark. It is regarded as a delicacy due to its hearty taste, that enhances the flavour of quark, which is otherwise bland.[2]

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Chemical aspects[edit]

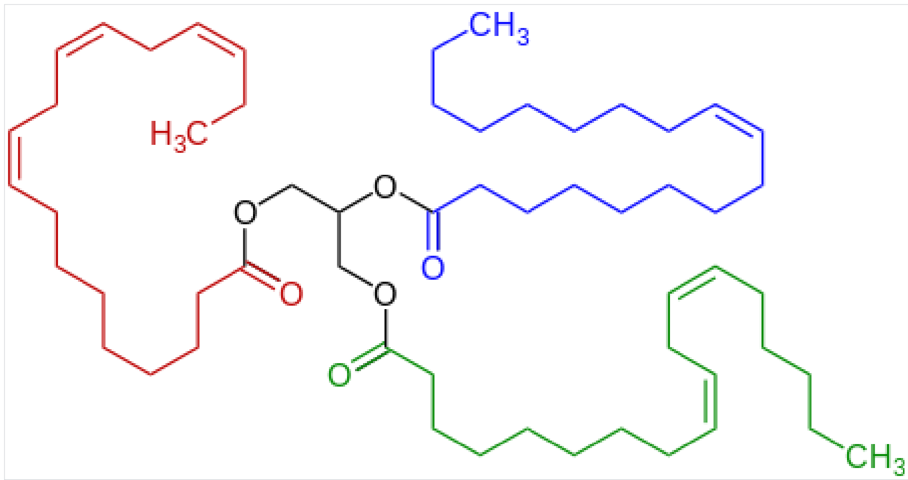
Linseed oil is a triglyceride, like other fats. Linseed oil is distinctive for its unusually large amount of α-linolenic acid, which has a distinctive reaction with oxygen in air. Specifically, the fatty acids in a typical linseed oil are of the following types:[3]

- The triply unsaturated α-linolenic acid (51.9-55.2%),
- The saturated acids palmitic acid (about 7%) and stearic acid (3.4-4.6%),
- The monounsaturated oleic acid (18.5-22.6%),
- The doubly unsaturated linoleic acid (14.2-17%).

Having a high content of di- and tri-unsaturated esters, linseed oil is particularly susceptible to polymerization reactions upon exposure to oxygen in air. This polymerization, which is called *drying,* results in the rigidification of the material.

The drying process can be so exothermic as to pose a fire hazard under certain circumstances. To prevent premature drying, linseed oil-based products (oil paints, putty) should be stored in air-tight containers.

Like some other drying oils, linseed oil exhibits fluorescence under UV light after degradation.[4]



Representative triglyceride found in a linseed oil, a triester (triglyceride) derived of **linoleic acid**, **alpha-linolenic acid**, and **oleic acid**.

Uses[edit]

Most applications of linseed oil exploit its drying properties, i.e., the initial material is liquid or at least pliable and the aged material is rigid but not brittle. The water-repelling (hydrophobic) nature of the resulting hydrocarbon-based material is advantageous.

Paint binder[edit]

"Your country needs flax .." U.S. WWII poster soliciting linseed oil for use in paint.

Linseed oil is a common carrier used in oil paint. It can also be used as a painting medium, making oil paints more fluid, transparent and glossy. It is available in varieties such as cold pressed, alkali refined, sun bleached, sun thickened, and polymerised (stand oil). The introduction of linseed oil was a significant advance in the technology of oil painting.

Putty[edit]

Traditional glazing putty, consisting of a paste of chalk powder and linseed oil, is a sealant for glass windows that hardens within a few weeks of application and can then be painted over. The utility of putty is owed to the drying properties of linseed oil.

Wood finish[edit]

When used as a wood finish, linseed oil dries slowly and shrinks little upon hardening. Linseed oil does not cover the surface as varnish does, but soaks into the (visible and microscopic) pores, leaving a shiny but not glossy surface that shows off the grain of the wood. **A linseed oil finish is easily repaired, but it provides no significant barrier against scratching. Only wax finishes are less protective.** Liquid water penetrates a linseed oil finish in mere minutes, and water vapour bypasses it almost completely.[5] Garden furniture treated with linseed oil may develop mildew. Oiled wood may be yellowish and is likely to darken with age. Because it fills the pores, linseed oil partially protects wood from denting by compression.

Linseed oil is a traditional finish for gun stocks, though a very fine finish may require months to obtain. Several coats of linseed oil is the traditional protective coating for the raw willowwood of cricket bats; it is used so that the wood retains some moisture. New cricket bats are coated with linseed oil and knocked-in to perfection so they last longer.[6] Linseed oil is also often used by billiards or pool cue-makers for cue shafts, as a lubricant/protectant for wooden recorders, and used in place of epoxy to seal modern wooden surfboards. Additionally, a luthier may use linseed oil when reconditioning a guitar, mandolin, or other stringed instrument's fret board; lemon-scented mineral oil is commonly used for cleaning, then a light amount of linseed oil (or other drying oil) is applied to protect it from grime that might otherwise result in accelerated deterioration of the wood.

Gilding[edit]

Boiled linseed oil is used as sizing in traditional oil gilding to adhere sheets of gold leaf to a substrate (parchment, canvas, Armenian bole, etc.) It has a much longer working time than water-based size and gives a firm smooth surface which is adhesive enough in the first 12–24 hours after application to cause the gold to attach firmly to the intended surface.

Linoleum[edit]

Linseed oil is used to bind wood dust, cork particles, and related materials in the manufacture of the floor covering linoleum. After its invention in 1860 by Frederick Walton, linoleum, or 'lino' for short, was a common form of domestic and industrial floor covering from the 1870s until the 1970s when it was largely replaced by PVC ('vinyl') floor coverings.[7] However, since the 1990s, linoleum is on the rise again, being considered more environmentally sound than PVC.[8] Linoleum has given its name to the printmaking technique linocut, in which a relief design is cut into the smooth surface and then inked and used to print an image. The results are similar to those obtained by woodcut printing.

Nutritional supplement and food[edit]

Flax seed oil is easily oxidized, and rapidly becomes rancid, with an unpleasant odour, unless refrigerated. Even when kept under cool conditions, it has a shelf life of only a few weeks.[9] [*dubious – discuss*] Oil with an unpleasant or rancid odor should be discarded. Oxidation of flax seed oil is a major commercial concern, and antioxidants may be added to prevent rancidification.[10] Linseed oil is not generally recommended for use in cooking, yet one study does show that the alpha linolenic acid (ALA) while bound in flaxseed was found to be stable for cooking. When bound to flaxseed ALA can withstand temperatures up to 350 degrees F (176.67 C) for two hours.[11]

Food-grade flaxseed oil is cold-pressed, obtained without solvent extraction, in the absence of oxygen, and marketed as edible flaxseed oil. Fresh, refrigerated and unprocessed, linseed oil is used as a nutritional supplement and is a traditional European ethnic food, highly regarded for its hearty taste. It contains the highest level of the omega-3 fatty acid ALA among vegetable oils.[12][*need quotation to verify*] Regular flaxseed oil contains between 52% and 63% ALA (C18:3 *n*-3). Plant breeders have developed flaxseed with both higher ALA (70%) and very low ALA content (< 3%).[13] The USFDA granted generally recognized as safe (GRAS) status for high alpha linolenic flaxseed oil.[14]

Nutrient content[edit]

Typical fatty acid content	% [15]	% European[16]
Palmitic acid	6.0	4.0–6.0
Stearic acid	2.5	2.0–3.0
Arachidic acid	0.5	0–0.5
Palmitoleic acid	-	0–0.5
Oleic acid	19.0	10.0–22.0
Eicosenoic acid	-	0–0.6
Linoleic acid	24.1	12.0–18.0
Alpha-linolenic acid	47.4	56.0–71.0
Other	0.5	-

Nutrition information from the Flax Council of Canada.[17]

Per 1 tbsp (14 g)

- Calories: 126
- Total fat: 14 g
- Omega-3: 8 g
- Omega-6: 2 g
- Omega-9: 3 g

Flax seed oil contains no significant amounts of protein, carbohydrates or fibre.

Additional uses[edit]

- Animal care products
- Bicycle maintenance as a thread fixative, rust inhibitor and lubricant
- Composition ornament for moulded decoration
- Earthen floors

- Animal feeds
- Industrial lubricant
- Leather treatment
- Oilcloth
- Particle detectors[18]
- Textiles
- Wood preservation (including as an active ingredient of Danish Oil)[*citation needed*]
- Cookware seasoning

Modified linseed oils[edit]

Stand oil[edit]

Stand oil is generated by heating linseed oil near 300 °C for a few days in the complete absence of air. Under these conditions, the polyunsaturated fatty esters convert to conjugated dienes, which then undergo Diels-Alder reactions, leading to crosslinking. The product, which is highly viscous, gives highly uniform coatings that "dry" to more elastic coatings than linseed oil itself. Soybean oil can be treated similarly, but converts more slowly. On the other hand, tung oil converts very quickly, being complete in minutes at 260 °C. Coatings prepared from stand oils are less prone to yellowing than are coatings derived from the parent oils.[19]

Boiled linseed oil[edit]

Boiled linseed oil is a combination of raw linseed oil, stand oil (see above), and metallic dryers (catalysts to accelerate drying).[19] In the Medieval era, linseed oil was boiled with lead oxide (litharge) to give a product called boiled linseed oil.[20][*page needed*] The lead oxide forms lead "soaps" (lead oxide is alkaline) which promotes hardening (polymerisation) of linseed oil by reaction with atmospheric oxygen. Heating shortens its drying time.

Raw linseed oil[edit]

Raw linseed oil is the base oil, unprocessed and without driers or thinners. It is mostly used as a feedstock for making a boiled oil. It does not cure sufficiently well or quickly to be regarded as a drying oil.[21] Raw linseed is sometimes used, such as for oiling cricket bats, when it is wished to increase surface friction, so as to give better ball control.[22] In the past it was also used to treat leather flat belt drives to reduce slipping.

Spontaneous combustion[edit]

Rags soaked with linseed oil stored in a pile are considered a fire hazard because they provide a large surface area for oxidation of the oil, and the oil oxidises quickly. The oxidation of linseed oil is an exothermic reaction, which accelerates as the temperature of the rags increases. When heat accumulation exceeds the rate of heat dissipation into the environment, the temperature increases and may eventually become hot enough to make the rags spontaneously combust.[23]

In 1991, One Meridian Plaza, a high rise in Philadelphia, was severely damaged and three firefighters perished in a fire thought to be caused by linseed oil-soaked rags.[24]

See also[edit]

- Flax seed
- National Linseed Oil Trust

Further reading[edit]

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External links[edit]

Linseed Oil, an Ancient Friend (and Foe)

By: **Christopher Schwarz** | October 9, 2014

5

When Egyptian King Tutankhamun was buried in haste, the linen cloth he was wrapped in was soaked with linseed oil. And, perhaps because Tut was buried in haste, the oil was not allowed to cure.

And so began one of the most common safety messages in relation to finishing: Spread out your oily rags to dry cure to avoid spontaneous combustion.

Yup. The oily rags that wrapped Tut's body spontaneously combusted, charring the body that Howard Carter discovered in 1922. You can read all about that event here.

This week I'm adding multiple thin coats of linseed oil to the oak aumbry I've built for an upcoming issue of *Popular Woodworking Magazine*, and in between coats of finish I've been getting in touch with my inner *Linum usitatissimum.* The flax plant has a long history with humans and their woodworking. One of the earliest domesticated plants, flax has long been exploited for its fibrous stalk and seeds.

In some parts of Europe its oil is used as a hearty flavoring to bland foods. But here in the United States, we use flax far more as a cloth – it is linen – and as an important component in finishing. It is the basic ingredient in oil paints and many other finishing products, most notably boiled linseed oil.

Plain linseed oil is a drying oil, meaning it will stiffen and dry when exposed to oxygen. But it takes a long time for this to happen – it can be days, depending on the ambient temperature. And so historically linseed oil was heated – sometimes with lead – to significantly shorten its drying time. Today linseed oil is transformed into "boiled linseed oil" by adding metallic dryers.

Stephen A. Shepherd discusses how you can make your own boiled linseed oil at home (with some precautions) so you can avoid contact with metallic dryers.

Details are in “Shellac, Linseed Oil, & Paint” (Full Chisel), which is available through his web site. The book is an interesting read.

I haven’t tried it, and so I use the off-the-rack “boiled linseed oil” from the home center and wear gloves when applying it.

As a stand-alone finish, linseed oil is an adequate finish, as long as you know its limitations.

Many beginning woodworkers use an oil-only finish because it is easy to apply and gives a nice low-lustre sheen. The main problem with linseed oil is that it doesn’t offer much protection against scratches or water. You can get around this problem by applying many, many thin coats of oil, like gunsmiths do, but this is time-consuming.

The other problem with a straight oil finish is that unless you apply many coats, the finish will lose its lustre in short order. So you have to wax the finish (and maintain that) or add more oil. I’ve seen many pieces of furniture from beginners that suffer from this problem – the wood looks dull, lifeless and like it is covered in a fine layer of dust.

Despite these limitations, I use boiled linseed oil a lot. It is a fantastic base coat for many projects because it will help accentuate the figure in the wood and will yellow over time (some people don’t like the yellowing; I do).

However, after applying the oil, I follow it up with something else that will add some protection.

If you don’t own special finishing equipment (such as a spray gun), I recommend you make your own topcoat finish from readily available sources. I use a finish that is equal parts spar varnish, boiled linseed oil and “odorless” mineral spirits. Just mix them up in a jar and you have a near-perfect wipe-on finish. Apply thin coats (I usually use three coats) and this finish will add enough protection for typical furniture. It also will prevent the straight oil below from drying out. I wouldn’t use this finish on a kitchen table, for example, unless I added a lot of coats.

Of course, when you finish with your finishing, you need to dispose of your rags properly so you don't burn your tomb down. I usually spread the rags out flat outside or temporarily on the edge of the garbage can until I can get them outside.

If you need the rag for the next coat of finish, you can seal it in a Ziploc bag with all the air removed. That will keep it moist.

I'll be honest, I've never had a problem with the rags heating up, even when I intentionally tried to start a fire. Last year I soaked a bunch of rags and put them in a tin can outside to see how long it would take to start a fire. No joy.

Oh well.

— *Christopher Schwarz*

If you are beginning finisher, I can offer no higher recommendation than Bob Flexner's "Wood Finishing 101." It is short, easy to understand and 100 percent free of misinformation. This book is only $12.50, but it's worth its weight in gold.

CATEGORIES
Chris Schwarz Blog, Wood Finishing, Woodworking Blogs