Crackle for Amateurs

By Lloyd Sponenburgh

Ned’s Note: Lloyd has some seriously good tips for making Nitrocellulose-Lacquer and Crackle micro-stars. Those micro-stars, embedded in a matrix of a charcoal comp, make great crackling comets and stars. Many folks want to know how to make them, and Lloyd shows us how.

For crackle, the formula is no secret. The real secret to getting good crackle is just getting enough NC in the mix. You’ll understand lower down in this project.

This formula has been circulating on the internet for years. I would imagine it will work with any crackling stars formula, per experimentation:

**Bismuth Trioxide Crackle Formula**

0.71  Bismuth trioxide  
0.14  Black copper oxide  
0.10  Magnalium (see notes)  
0.05  fine atomized aluminum (-300 mesh, like Service Chemical "X-Fine")

The magnalium for "regular" crackle is 200-mesh. The coarser the magnalium mesh, the longer the delay between ignition and explosion. At 80-mesh, it’s about three seconds, and pieces as large as ¼” will explode in a single explosion. The finer the magnalium, the smaller the pieces must be. At 200-mesh, 1/8" dia. stars are about as large as you can make them. Otherwise, they just spall small chunks, and the body remains un-reacted.

After screen mixing the crackle mixture, add up to 10% by weight of fine titanium sponge or flake to the original mixture (60-100 mesh) to get the "brocade" burst effect. If you add from +10% to +25% by weight of the fine titanium, it weakens the crackle and makes those beautiful "popping brocade" stars you see in so many Chinese cakes. The more Ti you add up
to a max of 20-25%, the richer it gets, and the softer the bursts, so they
don't sound so loud and sharp, but still give the "look". Too much Ti will
prevent them from bursting uniformly.

Around five pounds per batch is about as much as one person can handle
comfortably at one time. With hobbyist budgets, maybe making a batch
using a pound of the bismuth trioxide would be a good starting place.

**Bismuth Trioxide Crackle, 5 Pounds, 80 Ounces, 2300 Grams**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Factor</th>
<th>22.5 Ounces</th>
<th>640 Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bismuth Trioxide</td>
<td>0.71</td>
<td>16 oz</td>
<td>454.4 g</td>
</tr>
<tr>
<td>Copper Oxide, Black</td>
<td>0.14</td>
<td>3.15 oz</td>
<td>89.6 g</td>
</tr>
<tr>
<td>Magnalium</td>
<td>0.10</td>
<td>2.25 oz</td>
<td>64 g</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.05</td>
<td>1.1 oz</td>
<td>32 g</td>
</tr>
<tr>
<td>Titanium (Optional)</td>
<td>0.10 to 0.25</td>
<td>2.15 to 5.6 oz</td>
<td>64 to 160 g</td>
</tr>
</tbody>
</table>

The mixture is screened well, then mixed into a wet, sticky dough with
10% w/v nitrocellulose lacquer made from double-base powder

You may wish to mix up the NC lacquer detailed below, before you mix up
your batch of dry composition.

**Homemade Nitrocellulose Lacquer**

This NC lacquer is used to wet the above dry composition. Of course, NC
lacquer is used for many other purposes, so mixing up a supply at one time
is not a bad idea.

The batch spec'd below will wet about 3 of the batches of dry comp shown
above.

**Ingredients for a batch of NC lacquer**

50-60g (1.75-2 ounces) of double-based "disc" style powder like Green
Dot, Blue Dot, or Bullseye shotshell powder

500ml of acetone (a little more than 2 cups)
Putting about 30% of the above batch of lacquer into the 22.5 ounce batch of crackle composition, it will turn out way too wet to begin with. Stir until the dough thickens and dries to the desired consistency.

It needs to be that way to get enough NC in the mix, and anything thicker than about a 10-12% NC lacquer is too thick to work with well.

*I've only once made these with single-based powder, and found them satisfactory, but a bit less consistent in timing from ignition to crack. When I worked up these procedures, I was striving for a crackle which could be fired as tiny stars from a tiny mine, and "crash" all at once. I was only able to get that precision with the double-based powder. For those who don't have such a precise need, the single-base will work OK.

**Mixing the NC Lacquer**

There's a secret to making the lacquer that I've published over and over, and folks _still_ think it takes a couple of days to make. In reality, it only takes about 30-minutes.

Do the following steps in a Well Ventilated area.

Have a new, empty quart or gallon paint can, from a paint store or Home-Depot/Lowes, on hand to store the unused NC lacquer in.

Measure out the acetone in a metal vessel at least four times larger than the volume you're working with. (Acetone can soften common plastics.) I use a deep stainless steel mixing bowl from a kitchen mixer.

With a kitchen whisk in your strong hand, and the weighed NC powder in the other, start slowly but uniformly pouring the powder into the acetone while you whisk your arm off. Mix _fast_, and don't stop until the whole mass thickens up to about the consistency of heavy cream. Work lumps down off the sides of the bowl as you go. Don't ever let any un-dissolved powder settle to the bottom, or it will form large, _firm_ lumps that will not dissolve.

Now, cover the bowl and let it sit for about 30 minutes. Come back and whisk again for about three or four minutes, and your lacquer is ready. You can ignore any "soft lumps"; they'll dissolve during the kneading process.
Wetting the Crackle Composition with the NC Lacquer

If you haven’t already screen-mixed your dry crackle composition, do so now. If you’re adding titanium, do it after mixing the base composition.

In another large, shallow bowl, "crater" your crackle mix, and start adding NC lacquer, a little at a time - just like making bread dough.

Knead it thoroughly. At first, it will become "mealy" like making pie dough. As you add more NC, it will become more and more dough-like. Knead it until it's perfectly smooth and homogenous, and quite a bit on the sticky side of too wet. It should end up almost impossible to knead properly any more because it's too sticky to handle. It should be about the consistency of a very thick batter, rather than a dough.

This is hard work. Wear stout rubber gloves, such as furniture-stripping ones, which are impervious to the acetone. Scrape your gloves down into the wet mix to get the dried chunks back into the mass.

I know this might sound silly, but don’t allow sweat to drip into the dough… You will be sweating, and for safety reasons, you don’t want water to get into the crackle composition; it will react, and could catch fire.

It's important to the loudness of the crackle to get enough NC in there. If the dough ends up too sticky to handle, that's OK… Just mush it out flat and let it dry a little. As it dries (and it dries pretty fast) it will lose its stickiness. Keep working the wet mass until it returns to the consistency of a stiff dough.

Granulating the Wet Crackle Composition

Once the dough is back to the right consistency, more "push" than "scrape" it through standard ¼" hardware cloth onto trays lined with paper. You'll get ¼" "worms" about two inches long or less. Don't layer them more than a couple deep, or they'll all stick together. If they do stick, let them dry a little, knead them back into a lump, and push them through the screen again.

Let them dry slowly in the shade without molesting them just until you
can "diaper" the mass without having the worms stick to one-another. The goal is to get them partially dry, but not so dry you cannot further process them for smaller grains.

Working with a small amount at a time, push these worms through 6-mesh screening. 6-mesh gives 1/8" stars. Especially now, don't layer the mass; you must keep the stars from adhering to one-another.

As they dry a little more (the "knack" part comes now), put them back in the 6-mesh screen, and gently ROLL them back through the screen with the flat of your gloved palm. Avoid scraping or pushing straight down. What you're doing is basically rounding off the chunks and forcing them to size in one operation.

Let these stars dry thoroughly, occasionally diapering the mass to get damp ones to the surface. In the sun, they should dry completely in an hour or so. You should detect no acetone odor, but you will smell a "sharp" odor from the nitroglycerine in the NC lacquer.

Finally, re-screen the entire mass to remove chunks larger than 6-mesh, and sift out any "fines" smaller than about 10-mesh. The big pieces and the fines may be re-processed later simply by adding acetone and re-kneading. You can make really small stars for crackling gerbs with the -10+20 pieces, if you wish.

**Primming the Crackle Micro-Stars**

Now, prime the stars. Make up a saturated solution of potassium dichromate as your rolling solvent. **Do not use plain water** - the stars will react with water, and can actually ignite from the heat.

**Caution:** Observe the pertinent safety precautions when working with potassium dichromate. Wear safety glasses, a respirator, and good gloves. This is one of the most hazardous chemicals we work with in fireworking, and good safety measures are a must.

Start a fairly large mass of the dried stars rolling in your star roller. They must tumble freely. They're so heavy that a small mass will just slip around in the drum. In fact, they may not tumble at
all until you start to dampen them with solvent (gives a little "bite" on the surface of the drum).

Wet them with the solvent until they glisten, but still tumble freely. Lay on a layer of simple rough-mix powder (75/15/10 +7% dextrin). Do not mill this… you want it coarse; just mix it by screening repeatedly through 20-mesh. Just like star rolling, add dry mix until they'll not take up any more, but try to keep the layer smooth, without excess dry mix in the mass.

Do only a couple of layers. The goal is not to build them up in size, but just to evenly coat all surfaces of each grain. There shouldn't be any grey crackle showing, but the grains should be only marginally larger than when you started. Finish up with a large excess of dry powder to make the grains' surfaces "dusty" for easier ignition. Uniform ignition over the entire surface of the star is part of the secret to getting it *LOUD*.

Dry these again in the sun and gently sift out the excess priming mix, and you're done - with straight crackle.

**Crackle Stars and Comets**: Add about 25% crackle granules to 75% of your favorite glitter for a rich, loud rising tail with glittering afterglow. (weight to weight). Be careful to moisten and re-screen the glitter composition first, before adding the crackle. Then gently mix to distribute the crackle, but don't re-screen, lest you break up the grains or scrape off their prime.

Although this sounds like more work than making cut stars, it's lots faster, and turns out a good product. Even for cut stars, you have to do everything but the screening phases, and cutting uniform 1/8" stars is difficult.

Once you've made five _finished_ pounds of these, call me up, and we'll get you some therapy for your arms.

Let me know when you've achieved a forty pound day!

LLoyd