Directions, Cautions, & Tips

Overview

NanoLab was awarded a Small Business Innovative Research (SBIR) grant in November 2011 by NASA to study nanostructured optical black materials for glare suppression on their equipment, which eventually led to the development of the original Singularity™ Black paint formulation. The paint formulation was named "Singularity™" as a reference to the center of a black hole, where no light can escape. With feedback from the first Singularity users, we developed a lower temperature "*LT*" formulation to enable the coating of cloth, polymers, and other materials. The Singularity™ Black has the same structure and light absorbing characteristics of the materials we developed for NASA, now in a low temperature paint that is extremely effective at trapping light in the broadband.

Singularity™ Black *LT* can be only be applied to materials that will tolerate the paint solvent and the temperature necessary to drive off the binder inherent in the coating: cloths like canvas, wallboard, and certain thermally stable plastics & composites. It is not recommended for polystyrene, PTFE, and other low friction substrates.

Safety Protocol & Suggested Protective Gear

The solvent used for the Singularity™ Black *LT* paint is tetrahydrofuran or THF. This is a relatively non-toxic solvent, but requires proper safety precautions:

- Handle the paint with gloves to prevent it dissolving into the skin. THF will dissolve latex, so use nitrile or neoprene rubber gloves
- Exposure to THF fumes causes eye irritation, so use eye protection..

The following safety protocol is recommended when spray-coating the Singularity Black *LT* to limit exposure to aerosolized carbon nanotubes and solvent fumes:

- A spray-booth, fume hood, or well ventilated atmosphere is also recommended to host the spray-coating. If this environment is unavailable, the use of a mask that can also ventilate organic solvents is required.
- A respirator with a P95 cartridge that can filter out particles dispersed in the air during spray-coating is recommended. More information on selecting respirators can be found at https://blogs.cdc.gov/niosh-science-blog/2011/12/07/resp-nano/.
- Keep in mind that an airbrush may discharge the paint onto a larger area than what you are spray-coating, so a spray-booth that can withstand THF is recommended to encapsulate any extraneous paint.

Directions for Use

Surface Prep

Cloth: Rougher surfaces make blacker coatings. Slightly roughen surfaces with 120 grit sandpaper to create texture. Prime canvas with *Gamblin* PVA is recommended when Singularty LT is being used in conjunction with oil and acrylic paints.

Paper: SBI-LT can be spray applied to *Canson*140# watercolor paper as it is.

Wallboard: Unprimed wallboard can be texturized with vinyl spackle. Test any other primed/painted surfaces to ensure that it doesn't peel or react with SBI-*LT*.

Masking
Precise patterns with sharp edges can be formed using the Singularity Black paint through the application of masking materials on the substrate surface prior to coating. We recommend the use of *ScotchBlue* Brand painters tape as a mask because of it does not leave behind adhesive residue after coating the Singularity Black. Vinyl masking materials have also been demonstrated to withstand careful spray-coating procedures. Lightly heating the vinyl to 'slump' it onto the surface is recommended.

Mixing
Dilution is not recommended. The coating is a single system, which can be diluted with tetrahydrofuran. The paint should be mixed thoroughly (a paint shaker, or 2-3 minute stirring) just before coating.

Process
Paint and activate SBI-LT first, then paint other colors up to the edge. SBI-*LT* can be touched up, and re-activated near other paints. Apply heat gently.

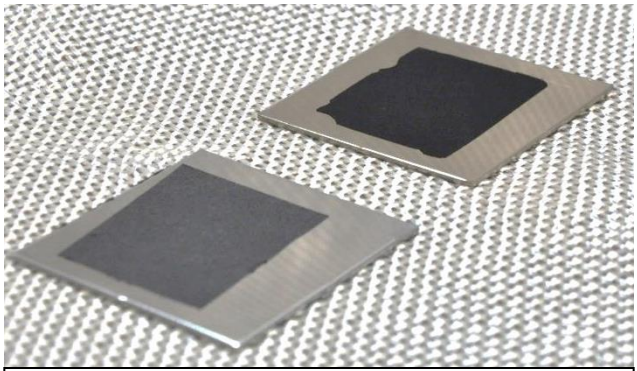
Application: Spray-coating
The Singularity™ Black paint is compatible with many spray guns & air brushes. For spraying relatively small volumes of paint, we recommend the *Badger Model 150*, with a medium tip and an operating pressure of 35psi. This reservoir holds 2oz (60ml) of the coating. For larger parts, we recommend the *Devilbiss Compact MINI HVLP* Touch-Up Spray Gun. This gun operates well at 10 psi, and has a 9oz (265ml) cup. Follow included instructions for these sprayers. A video is available on our you tube channel NanoLab, Inc, on our website, and here is the url for it here: https://youtu.be/A5Ypt-P10zs

Spray-coating technique tips:

- Lay the substrate flat and steadily scan the spray gun to apply an even coating, about 8-10in from the substrate. Multiple coats are applied, with typically 3-5 seconds between passes to allow the solvent to dry between layers. Each coating should scan over the edges of the intended area to prevent any edge defects. At no point should the coating look wet or congealed.
- Apply about 1mL per cm^2 of the coating area, or until each pass doesn't appreciably change the color of the wet coating. It is recommended when spraying onto rougher surfaces (textiles, wood, etc.) that the substrate is rotated 90°, 180°, and 270° during the coating.
- Dry the coating at warm temperatures between 80-100°C for 20-30min or in air for 1-2 hours to fully evaporate the solvent and settle the wet coating prior to any mask removal or thermal post-treatment.

Heat-treatment
After painting, the paint must be dried in warm air for 1-2 minutes to allow the solvent to evaporate from the coating. All masking materials must be removed after the coating is dried prior to the thermal treatment. The dried coating can be cut with a razor around the mask to minimize coating damage during removal of the mask.

The thermal treatment can be conducted in a variety of ways. The critical goal is to heat the coating to the necessary temperature to burn-off the binder. The *LT* binder can be removed in air using a paint stripper, hair dryer, propane torch, or an oven, furnace, or kiln capable of reaching a temperature of 150°C, which subsequently yields the supremely black coating. Move quickly to evenly heat the material when using direct heat. The heating rate affects the porosity of the CNT network yielded after the binder is removed, and thus rapid insertion into an environment pre-heated to the required temperature is most effective. Fast heating & cooling rates of



(below left) dried Singularity™ Black coating before thermal treatment, (above right) thermally treated Singularity™ Black coating

approximately 360°C/hour or more are recommended. Do not overheat. Above 450C in air, the coating can oxidize, negatively impacting the coating color.

Packaging

Singularity™ Black *LT* is packaged in lined steel cans, for 250, 500 and 1000ml volumes. Additonal package sizes are available on request.

Handling

Although the cured coating is adhered to the substrate, it is not highly scratch resistant, and thus careful handling is recommended. Avoid directly rubbing, scratching, or excessive handling to prevent damage to the film. Damaged coatings can be recoated if needed by repeating the coating/curing procedures on the affected area. If you are interested in a more abrasion resistant surface for easier handling, please contact sales@nano-lab.com to hear more about our adhesive primer coating currently available as part of NanoLab's coating services.

NanoLab, Inc
22 Bedford St.
Waltham, MA 02451

www.nano-lab.com
sales@nano-lab.com
Tel 781 609 2722