GRACE Davison

LUDOX® CL-X
LUDOX® CL-P

Colloidal Silica for Frictionizing Paper and Linerboard Surfaces

Table 1. Typical Properties

Property	CL-X	CL-P
%Solids (w/w)	46	42
Particle Size (nm)	22	22
Particle Charge	Negative	Positive
Specific Surface Area (m^2/g)	140	140
Specific Gravity (25°C)	1.37	1.30
pH	9	4
%Ethylene Glycol	7	0

LUDOX® colloidal silica can be applied as a clear surface treatment on paper and linerboard products to increase their coefficients of friction. This results in a surface with improved antiskid or antislip properties. Paper rolls are less susceptible to telescoping and paper sheets move through transport rollers more easily. Boxes and corrugated sheets are less susceptible to slipping and sliding during transportation and in storage and the smooth, evenly distributed coating will enhance printing on boxes. Typical products that can benefit from frictionizing treatment include corrugated sheets and boxes, linerboard paper, photocopier papers, and recycled papers.

While a number of colloidal silica grades may have possible utility, LUDOX CL-P and CL-X have been specially formulated to give superior performance and easy cleanup from coating machine surfaces. Typical properties of these two grades are given in Table 1.

Benefits of LUDOX CL-X and CL-P

- Invisible surface treatment
- Easy cleanup
- Excellent slide angle performance
- Good friction retention
- No agitation required
- Economical with high dilutions
- Enhanced printing

Which grade to use?

The choice should be made based on the user's equipment and needs. CL-P contains positively charged particles that attach more efficiently to negatively charged paper fibers. This characteristic often makes CL-P more economical than CL-X in that less silica coverage is required to achieve the desired frictionizing effect. It also has no volatile organic compounds (VOC's). CL-X contains a small amount of ethylene glycol to aid cleanup while CL-P exhibits good or better cleanup without ethylene glycol. On the other hand, CL-X is an alkaline solution and CL-P is slightly acidic. CL-P may corrode coating equipment made of mild steel but is compatible with other equipment.

Application

The colloidal silica can be easily applied with rollers, sponges, felts and doctor blades. Spray systems should be avoided to prevent worker exposure to colloidal silica mists or aerosols.

Application of the colloidal silica should be one of the last steps in the paper manufacturing process. Treatments for corrugated boxes are

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Figure 1. Slide Angle Test Apparatus

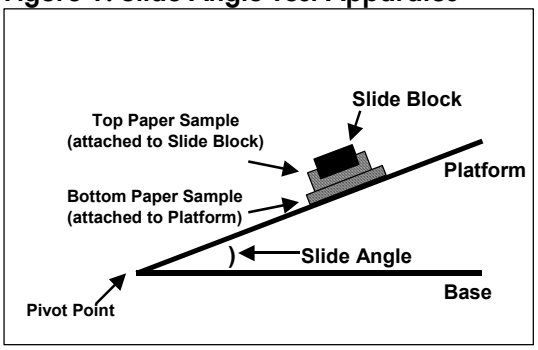
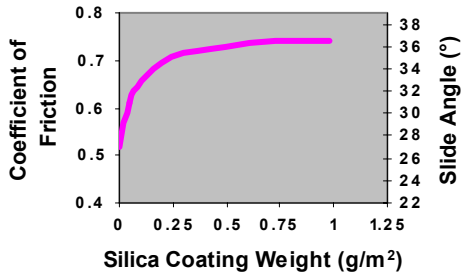


Figure 2. Degree of Frictionizing



Application (continued)

normally applied on the corrugator at a point between the hot plates and slitter. This location is preferred because the pit area often has adequate space for the application equipment and the hot board has time to dry before slitting and stacking. Corrugators prefer sponge and felt applicators while multi-wall bag manufacturers usually use solid transfer rolls. Mixing the colloidal silica with other solid components, such as sizing, will often compromise frictionizing performance. Performance may also be impaired if more than about 25% of the treated surface will be subsequently coated or printed. In this case, another frictionizing treatment will be needed.

The frictionizing effect depends almost entirely on the amount of solids applied to the paper surface. Depending on the surface and end-use, the coverage in terms of silica solids is typically about 0.5-1 g/m^2 (0.1-0.2 lb/1000 ft^2). Actual coverage requirements on the particular paper must be determined experimentally.

The CL-X or CL-P is usually diluted with water. The amount of dilution depends on the coating equipment and the amount of liquid it can apply to the paper surface. We suggest starting with a dilution ratio of 1 part of the colloidal silica concentrate and 10 parts of water and adjust accordingly to achieve the desired frictionizing performance. Dilutions of 1 part concentrate to 6-12 parts water are typical.

The frictionizing effect is usually measured with a slide angle tester, shown schematically in Figure 1. While such a system can be handmade, several mechanical testers are available that offer better reproducibility. Please refer to TAPPI test methods T-502 and T-815 or ASTM test methods D4521 and D4918 for more information. Typically, separate samples of the test paper are attached to the movable platform and to the test block such that the treated sides are in contact. The platform is then tilted slowly either by motor or by hand. The slide angle is determined by the angle between the platform and the base at the point that the test block starts to slide. The coefficient of friction is determined by the equation:

Coefficient of Friction = Tan(Slide Angle)

Depending on the paper, slide angle increases of 8-20° are typical.

Figure 2 shows an idealized graph of a treated paper. In this example, an untreated paper has a coefficient of friction of about 0.50 and a slide angle of about 27°. Below a dry solids dosage of 0.2 g/m2, the coefficient of friction and slide angle increase proportionally with dosage, after which they level off to a "plateau region." The user should establish process conditions

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Table 2.
Dilution Ratio and Specific Gravity

Dilution Ratio	Specific Gravity (25°C)	
Parts Colloidal Silica Concentrate: Parts Water (Volume)	CL-X	CL-P
1:3	1.093	1.076
1:4	1.075	1.060
1:5	1.062	1.050
1:6	1.053	1.044
1:8	1.041	1.033
1:10	1.034	1.027
1:12	1.029	1.023
1:15	1.022	1.019

Application (continued)

that target the plateau region, which is between 0.2 and 1 g/m^2 in this example. The user will experience run-to-run variability below this range and will waste product above it.

Quality Control

Once the proper dilution ratio is determined, the diluted product can be checked by hydrometer. Table 2 gives Specific Gravity as measured at 25°C (77°F) at different dilutions. The user should always measure at the same temperature to assure good quality control.

Silica coverage of the final product can be checked qualitatively with LUDOX Indicator Solution. More quantitative checks can be made with a slide angle tester.

The Troubleshooting Guide in Table 3 offers a number of corrective actions for the most common problems encountered.

Storage and Handling

LUDOX CL-X and CL-P are stable for at least one year from the date of manufacture, provided it is not contaminated or allowed to dry by evaporation. Unlike most colloidal silica products that gel irreversibly when frozen, CL-X and CL-P can often be reconstituted by mixing without affecting performance. In general, though, both freezing (0°C/32°F) and hot (above 43°C/110°F) storage conditions should be avoided to reduce the risk of irreversible gelation.

The product should be stored in tightly closed containers to avoid evaporation.

Spills should be wiped up immediately or flushed with plenty of water. Workers should wear safety glasses and rubber or plastic gloves. CL-X and CL-P may cause irritation to the eyes and skin, especially with repeated contact. The production of respirable aerosols or mists, as from spraying equipment, should be avoided. The Material Safety Data Sheet (MSDS) for these products should be read carefully for important safety information.

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Table 3. Troubleshooting Guide

Problem	Cause	Corrective Actions
Low Slide Angle	Too little colloidal silica applied o Treating solution too dilute o Too little solution applied o Poor applicator contact with paper o Sponges plugged o Colloidal Silica covered by wax, silicone lubricant or printing. o Test panel sprayed with Indicator Solution	Use Indicator Spray to Confirm o Decrease dilution ratio o Raise liquid overflow level o Correct sponge/felt/roller position to improve contact o Clean out sponges o Discontinue waxing of boxes; search out pick up points; frictionize after printing o Do not spray before slide angle test.
Poor Indicator Response	o Too little colloidal silica applied o Wet paper or board	o See Low Slide Angle section. o Dry before testing
Very Dark Indicator Color	Too much Colloidal Silica applied o Treating solution too concentrated o Too much solution applied	o Increase dilution ratio o Reduce liquid overflow level in pan
Variable Coverage	o Fluctuating solution level in pan o Sponges or felts plugged o Hold down bar skipping	o Install continuous overflow-recycle system o Clean sponges or felts o Increase hold down bar pressure
Streaking	o Sponges or felts plugged o Solution level too low o Roller speed too high	o Clean sponges or felts o Raise liquid overflow level o Reduce speed or use soft rubber roller (20-30 durometer)
Washboarding, Warping	o Too much wetting	o Reduce application rate o Raise overflow level (may have to compensate with lower dilution ratio)

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