Sinotech Environmental Technologies Limited

Manufacturing Quality Assurance
Policies and Procedures

This manual contains proprietary information belonging to Sinotech Environmental Technologies Limited. Any information contained herein is not to be discussed with others outside the involved organizations, except with the express prior written consent of Sinotech’s management.

This manual replaces in its entirety and supersedes all earlier versions issued by Sinotech Environmental Technologies Limited. We suggest you maintain contact with your Sinotech representative to confirm the validity of this version at future dates.

Sinotech Environmental Technologies Limited reserves the right to change, modify, or discontinue the use of the policies and procedures described herein without notice or prior consent except as contractually obligated to do otherwise.
1.1 Introduction
This manual is intended to describe the Quality Control and the Quality Assurance philosophy of Sinotech Environmental Technologies Limited and to set procedures for achieving a structured approach towards attaining the high quality of the products and services as demanded by the customers, and, to satisfy the company’s need for a systematic procedure operated by an effective and efficient Quality Control department within the organization.

1.2 Manufacturing Quality Assurance Policy
Sinotech’s manufacturing Quality Control policy is to adhere to the highest standards of quality. All employees are required to strictly adhere to all published Quality Control standards at all times. Quality Assurance is an attitude that must prevail among all employees and that attitude, coupled with a strong Quality Control program, will ensure the highest quality product possible.

Sinotech’s Quality Control and research laboratory will perform concurrent testing to assure control over all products. The laboratory will also be capable of supporting manufacturing, product development, and research needs. To this end, Sinotech is sensitive to Quality Assurance suggestions offered by plant and filed personnel, and welcomes the suggestions of its customers.

Our Quality Control Program is an ongoing system of monitoring and testing materials as they are delivered and manufactured. The Quality Control Department reserves the right to reject all raw materials or manufactured materials not meeting Sinotech specifications.

Our Quality Assurance verifies compliance with accepted procedures for training, manufacturing processes, Quality Control testing, material handling, and data review and distribution. Including verifying the validity of test results, the correctness of test procedures, and the proper operation of the test equipment.

These procedures apply to all production and must be adhered to at all times. They should be updated at least annually. Conformance to procedures will be monitored at a minimum once per year. This supersedes all previous procedures relating to Quality Control.

1.3 Quality Assurance Laboratory
Sinotech’s Quality Control Laboratory is fully equipped to perform a wide range of conformance testing on geosynthetic products. All samples are die cut to ensure uniformity and to meet ASTM requirements. Specimens not meeting ASTM standards are rejected. All Quality Control test results are stored in a computer database for ease of retrieval.

1.4 Equipment Maintenance
All laboratory equipment is periodically checked for proper calibration. Insertion equipment is self-calibrating and the calibration sequence is performed at the beginning of each test. All laboratory tensile testing machines are calibrated annually, within ASTM E-4 specifications, by an independent agency. The equipment is routinely checked to ensure proper operating conditions.

1.5 Material Quality Assurance
Our testing involves short term testing aimed at “finger printing” the raw material supplied. Every resin demonstrates its own individual characteristics that is determined by its chemical make-up and molecular weight. For reference purposes, density and melt index serves to identify the material as being acceptable or not. A visual inspection for contaminants is also performed.

1.5.1 Raw Material Testing
Sinotech has established specifications with which each lot of raw material must comply. The raw material suppliers must agree to comply with these specifications. Specific tests must be conducted by the supplier on every lot of material, the results of which are submitted and verified via selected conformance testing at Sinotech’s laboratory.

Each container (33,000 lbs.) of resin is not unloaded until testing is conducted by Sinotech to confirm that the quality of the material is set within parameters established by Sinotech. This testing consists of density, melt flow index and volatile content. All non-conforming materials are immediately isolated and the supplier is contacted. All departments are notified and the shipping/receiving personnel are instructed to complete all paperwork necessary to return the defective materials to the supplier.

Upon verification of material compliance a formal document releasing the material for unloading and/or use is issued. The incoming resin used by manufacturing is continually monitored by the Quality Control department.

1.5.2 On-line Manufacturing Quality Assurance
Our smooth sheet is monitored on an ongoing basis. As the geomembrane is being produced, thickness readings are taken continuously over the entire sheet. This data is used to determine the minimum, maximum and average thickness values for
each roll and are verified by thickness testing upon sampling of the finished goods. Standard testing (tensile, thickness, carbon black dispersion, etc. and visual inspection) is conducted at least every other roll of sheet production.

The textured sheet is also monitored on an ongoing basis. As the geomembrane is being produced, thickness readings are taken continuously over the entire sheet. This data is used to determine the minimum, maximum and average thickness values for each roll and are verified by thickness testing upon sampling of the finished goods. Standard testing (tensile, thickness, carbon black dispersion, etc. and visual inspection) is conducted at least every other roll of sheet production.

1.5.3 Spark Testing
An electrical spark detector is located on every production line. This provides immediate notification of holes in the finished sheet. If a hole is detected the alarm is triggered and the hole located. Rolls containing holes are immediately rejected and removed from the standard product inventory.

1.6 Material Identification
All rolls are labeled with two self adhesive stickers, one protruding from the roll at one end and a second positioned under the first layer at the opposite end of the roll. When the material is shipped we record the label for Quality Control certification. The roll is then loaded by either crane or forklift, depending on the type of transportation required by the customer, be it a standard forty foot container or open top container.

Extrusion rods are labeled by hand with a permanent marker on the label located at the end of the reel. When the extrusion rod is shipped, shipping personnel record the rod number, shift production, and rod weight. This information is given to Quality Control for certification purposes. The extrusion rod is then bagged for shipment.

1.7 Records Retention
For each roll produced, a sample is cut, identified and archived for a minimum period of 5 years.

When test results become available they are then immediately entered into Sinotech’s laboratory database from which all quality control certificates are generated. This database is backed up daily to guarantee that all data is retained. This database can also generate reports for specific orders, projects, types of material, dates of manufacture, thicknesses, resin batch numbers, etc. Test results and statistical control reports are made available to clients upon request.

In addition to finished product data, all resin supplier quality assurance documents, Sinotech resin test reports, and resin samples are retained for a period of 5 years.

1.8 Laboratory Technician Scheduling
Sinotech’s laboratory is staffed whenever production is occurring; this is 24 hours a day 365 days a year. This minimizes the possible occurrence of substandard material being manufactured prior to identification of the problem.
Introduction

Upon arrival of raw materials to our facilities in Qingdao, China the raw materials are not used for production of geomembranes until all testing is conducted and satisfactory test results are obtained. The following tests are conducted on each 50,000 kg of resin received.

Density
- Density is determined in accordance with the procedure established in ASTM D1505.
- Prepare a constant temperature density column by filling a graduated cylinder with fluids of continuously varying density, such that the density gradient is achieved throughout the height of the cylinder.
- Prepare three (3) specimens of material to be checked for density. Each specimen should be approximately 0.2 inches across. The specimen can be of any shape.
- Lower the specimen and glass beads of known densities into the density column.
- Observe the location of the glass beads and the specimen using graduations etched in the cylinder.
- Calculate the density and report the results in units of grams per cubic centimeter.

Melt Flow Index
- Melt Flow Index is determined in accordance with the procedure established in ASTM D12138 - Condition E.
- Heat a plastometer to 190ºC.
- Add 3.7 grams of resin to the cylinder of the plastometer, compact the resin, add piston, and place 2.06 kilogram weight in piston.
- Allow the plastometer to rest. At the conclusion of eight (8) minutes remove and discard all the plastic which has been extruded through the 0.0825 inch diameter hole at the end of the cylinder opposite the piston.
- Allow plastometer to rest for an additional ten (10) minutes. At the conclusion of the test period, remove the extruded plastic and allow it to cool at laboratory conditions.
- Weigh the extrude and report the results in units of grams per ten (10) minutes.

Oxidative Induction Time
- Oxidative Induction Time is determined in accordance with the procedures established in ASTM D3895.
- Compression mold a sample into sheet format (thickness of 250 ± 15 µm)
- Use a bore hole cutter to punch out a disk from the plaque and record the sample weight.
- Place the sample disk into the appropriate pan type.
- Prepare an empty sealed pan to be used as a reference.
- Place the specimen and reference pans into the instrument cell.
- Turn on the nitrogen-gas flow at a rate of 50 mL/min (with an absolute pressure of 140 kPa).
- Allow 5 min for a nitrogen pre purge prior to beginning the heating cycle to eliminate any residual oxygen.
- Commence programmed heating of the sample from ambient temperature to 200°C at a rate of 20°C/min.
- When the temperature has been reached discontinue programmed heating and equilibrate the sample for 5 min at the set temperature.
- Once the equilibrium time has expired, change the gas to oxygen at a flow rate of 50 ± mL/min. This is considered the zero time of the test procedure.
- Continue isothermal operation until 2 min have elapsed after the steepest point of the exotherm has been displayed.
- Plot the data with the heat flow signal on the y-axis, versus time on the x-axis.
- Report the results in minutes.

Once it is determined that the raw material meets production specifications, the resin is then pumped from the container into it's assigned silo dedicated to that material. All raw material which does not meet our production specifications is returned to the supplier.
### Minimum Testing Frequencies for Sinotech Natural Resin

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Natural Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ASTM D1505</td>
<td>Once per container</td>
</tr>
<tr>
<td>Melt Flow Index</td>
<td>ASTM D1238 (190/2.16)</td>
<td>Once per container</td>
</tr>
<tr>
<td>Oxidative Induction Time</td>
<td>ASTM D3895 (1 atm @ 200°C)</td>
<td>Once per resin lot</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603, modified</td>
<td>n/a</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>ASTM D5596</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Note: All procedures and values are subject to change without prior notification.

### Minimum Properties for Sinotech Natural Resin

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>HDPE</th>
<th>LLDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, g/cm³</td>
<td>ASTM D1505</td>
<td>0.932</td>
<td>0.915</td>
</tr>
<tr>
<td>Melt Flow Index, g/10 min.</td>
<td>ASTM D1238 (190/2.16)</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>Oxidative Induction Time, minutes</td>
<td>ASTM D3895 (1 atm @ 200°C)</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: All procedures and values are subject to change without prior notification.
Introduction

The following tests are performed by our laboratory personnel in accordance with the standard test methods detailed in the indicated ASTM section unless otherwise noted, and are made for explanatory purposes only. The primary properties of the finished geomembrane is tested every other roll. Products must be sampled from every other roll. Samples must be taken even if they cannot be tested until a later date. Sampling is done by production personnel.

The following tests are performed on our smooth sheet at least every other roll.

Thickness
- Thickness is determined in accordance with the procedures established in ASTM D5199.
- For the laboratory sample, take a full width sample of sufficient length along the selvage or the edge of the roll.
- Remove test specimens from the laboratory sample in a randomly distributed pattern across the width with no specimen taken nearer than 152 mm (6 inches) from the edge.
- From each laboratory sample, remove the specimens so that the edge of the specimen will extend beyond the edge of the presser foot by 10 mm (0.39 inches) in all directions (that is at least a circle of 75 mm [3 inches] diameter).
- With force applied to the presser foot on the base (no test specimen present), zero the measuring scale or record the “base reading”.
- Lift the presser foot, center the test specimen on the base under the presser foot, and bring the presser foot into contact with the material. Gradually increase the pressure to 20 kPa (2.9 psi).
- After the full force has been applied to presser foot for 5 seconds against the specimen, record the thickness value to the nearest 0.002 mm and remove the specimen from the test device.
- Repeat the method for each of the remaining specimens.
- Calculate the average of the thickness for all the test results as read directly from the test instrument.
- Report average nominal thickness.

Tensile Properties
- Tensile Properties is determined in accordance with the procedures established in ASTM D6693.
- Die cut five (5) dumbbell shaped specimen with the length parallel to the machine direction and five (5) with the length perpendicular to the machine direction using an ASTM D 6693 Type IV die.
- Measure the width and thickness of rigid flat specimens in accordance with ASTM D5199.
- Insert the ends of the specimen into the jaws of the testing machine, aligning the long axis of the specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. The jaws should have an initial separation of 65 millimeters.
- Start the machine so the jaws separate at a rate of 50 mm/min.
- Continue separating the jaws until the specimen breaks.
- Calculate the strain at yield and break. Report in units of percent. A 33 millimeter gage length is used for yield calculation. A 50 millimeter gage length is used for break calculations.

Tear Resistance
- Tear Resistance is determined in accordance with the procedures established in ASTM D1004.
- Die cut ten (10) samples with the length parallel to the machine direction and ten (10) samples with the length perpendicular to the machine direction.
- Measure the thickness of the sample at several points.
- Place the sample in the grips of the testing machine so that the long axis of the sample is in align with the points of attachment of the testing machine.
- Apply a load of 51-mm (2-in.)/min rate of grip separation.
- After complete rupture of the sample, the maximum tearing load in pounds shall be noted from the dial scale or recorder chart and recorded.
- Report the average resistance to tearing for all samples and record in pounds.

Puncture Resistance
- Puncture Resistance is determined in accordance with the procedures established in ASTM D4833.
- Cut ten (10) samples with a minimum diameter of 100 mm (4 in.).
- Center and secure the sample between the holding plates of the testing apparatus.
- Test at a machine speed of 300 ± 10 mm (12 in. ± ½ in.)/min. until the puncture rod completely ruptures the test specimen.
- Read the puncture resistance from the greatest force registered on the recording instrument during the test.
- Report the results in units of pounds.
Stress Crack Resistance
- Stress Crack Resistance is determined in accordance with the procedures established in ASTM D5397.
- Die cut thirty (30) dumbbell shaped samples, each sample must be from one direction.
- Cut into each sample a control imperfection (notch) on one surface. The depth of the notch should produce a ligament thickness of 80% of the nominal thickness of the sample.
- Calculate the tensile force to be applied to each individual sample.
- Fill the test bath with reagent, and adjust the temperature to 50 ± 1°C (122 ± 2°F).
- Attach the sample to the hooks of the test apparatus.
- Immerse the samples and allow temperature equilibrium to be reached.
- Load each sample with its respective weight and record the elapsed time to failure to the nearest 0.1 hour.
- Report the test data in graphic form by plotting the logarithm of percentage yield stress versus the logarithm of the average failure time for each stress level.

Carbon Black Content
- Carbon Black Content is determined in accordance with the procedures established in ASTM D1603.
- Place a weighed quantity of polyethylene in a 600°Celsius tube furnace with a flowing, oxygen free, nitrogen atmosphere.
- Allow the sample to remain in the furnace for fifteen (15) minutes. During this time all of the polyethylene should boil off leaving only the carbon black.
- Cool the carbon black for fifteen (15) minutes in a desiccator. Weigh.
- Report the results in units of percent.

Carbon Black Dispersion
- Carbon Black Dispersion is determined in accordance with the procedures established in ASTM D5596.
- Select five samples randomly across the full roll width. Sample size should each be approximately 2.54 cm² (1 in.²).
- Using a microtome, prepare one thin section in the cross-machine direction from each sample. Each thin section should be (1) thin enough (8 to 20-μm thick) to allow for adequate light transmission and (2) free from major defects such as gouges caused by a nicked or dull knife, or such as torn or distorted portions of the thin sections caused by over-stressing or rough handling.
- Mount each excised thin section between a microscope slide and a cover glass, using a clear adhesive medium.
- Prepare the microscope for transmitting light microscopy with the calibrated reticle positioned between one eyepiece lens and the objective.
- Before attempting any close, microscopic examination of the thin section, place the mounted thin section on the microscope stage positioned between the light source and the objective.
- Place the overlay microscope slide on top of the mounted thin section so that each of the two circles on the overlay overlaps the thin section fully. The area within the circles is called a random field of view or (Rf).
- View the sample at 100X.
- Examine each Rf microscopically, and locate the largest carbon agglomerate or inclusion.
- Compare visually the microscope’s field of view containing the largest carbon agglomerate in the Rf with the carbon Adjunct D35) dispersion reference chart.
- Record the category that resembles that field of view most closely.
- Repeat the above procedures until ten category readings are recorded. No more than two Rf’s are taken from each of no less than five thin sections.
- Report the category for each field of view.

Oxidative Induction Time
- Oxidative Induction Time is determined in accordance with the procedures established in ASTM D3895.
- Compression mold a sample into sheet format (thickness of 250 ± 15 μm).
- Use a bore hole cutter to punch out a disk from the plaque and record the sample weight.
- Place the sample disk into the appropriate pan type.
- Prepare an empty sealed pan to be used as a reference.
- Place the specimen and reference pans into the instrument cell.
- Turn on the nitrogen-gas flow at a rate of 50 mL/min (with an absolute pressure of 140 kPa).
- Adjust the temperature-calibration software to set the melting point at 156.63 and 231.97°C for indium and tin, respectively.
- Load the sample and reference pans into the cell.
- Allow 5 min for a nitrogen prepurge prior to beginning the heating cycle to eliminate any residual oxygen.
- Commence programmed heating of the sample from ambient temperature to 200°C at a rate of 20°C/min.
- When the temperature has been reached discontinue programmed heating and equilibrate the sample for 5 min at the set temperature.
- Once the equilibrium time has expired, change the gas to oxygen at a flow rate of 50 ± mL/min. This is considered the zero time of the test procedure.
- Continue isothermal operation until 2 min have elapsed after the steepest point of the exotherm has been displayed.
- Plot the data with the heat flow signal on the y-axis, versus time on the x-axis.
- Report the results in minutes.

**High Pressure OIT**
- High Pressure OIT is determined in accordance with the procedures established in ASTM D5885.
- Cut several round samples 6.3 mm (0.25 in.) from the lab test sample.
- Compression mold these samples into a uniform plaque to a thickness of 0.25 mm (10 mil).
- Cut samples from the plaque using a 6.3 mm (0.25 in.) bore hole cutter or punch.
- Prepare a sample with a mass of 5 ± 1 mg.
- Place the weighed sample into a cleaned specimen pan.
- Place the sample and reference pans into the cell.
- Close the pressure release valve and the inlet valve of the cell.
- Adjust the pressure of the cylinder regulator to deliver 3.4-MPa (500-psi) test pressure.
- Slowly open the inlet valve of the cell and allow oxygen to purge the cell for 2 min.
- After 2 min, close the outlet valve, allow the cell to reach full pressure, then turn off the inlet valve and the oxygen supplied from the cylinder.
- Commence programmed heating of the specimen from ambient temperature to 150°C at a rate of 20°C/min.
- Zero time is taken at the initiation of the temperature program.
- Hold the temperature isothermally at 150°C until the oxidative exothermic peak is detected.
- At the same time, the thermal curve of the entire test is being recorded.
- Record the sample temperature 5 min after isothermal conditions have been reached.
- Terminate the test after the oxidative exothermic peak has passed through its maximum value.
- Plot the data with the heat flow signal on the y-axis, versus time on the x-axis.
- Report the results in minutes.

A visual inspection is made of the liner material to ensure that it is free of pores, pinholes, or other detrimental defects.

From the daily production testing, a quality certificate is issued by the laboratory.
## Sinotech HDS Geomembranes

### High Density Polyethylene (HDPE) Smooth Testing Frequencies and Properties

Sinotech HDS geomembranes are produced from high density polyethylene (HDPE) resins resulting in a high quality premium grade, flexible geomembrane. Sinotech HDS has been formulated to be chemical resistant, free of leachable additives and resistant to ultraviolet degradation.

### Sinotech HDS Geomembranes Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Minimum Values for Sinotech HDS Geomembranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinotech Product Code</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness, mm</td>
<td>D5199</td>
<td>every roll</td>
<td>HDS 030 0.27 0.45 0.68 0.90 1.35 1.80 2.25 2.70</td>
</tr>
<tr>
<td>Density, g/cc</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.94 0.94 0.94 0.94 0.94 0.94 0.94 0.94 0.94 0.94</td>
</tr>
<tr>
<td>Tensile Properties (both directions)</td>
<td>D6693, Type IV</td>
<td>every 2 rolls</td>
<td>8 14 21 28 43 57 71 85</td>
</tr>
<tr>
<td>- Strength at Break, N/mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Strength at Yield, N/mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Elongation at Break, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Elongation at Yield, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tear Resistance, N</td>
<td>D1004</td>
<td>every 2 rolls</td>
<td>40 65 93 125 187 249 311 373</td>
</tr>
<tr>
<td>Puncture Resistance, N</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>105 176 263 400 530 703 881 1059</td>
</tr>
<tr>
<td>Stress Crack Resistance, hours</td>
<td>D5397 (App.)</td>
<td>90,000 kg</td>
<td>400 400 400 400 400 400 400 400 400 400</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>D1603</td>
<td>every 2 rolls</td>
<td>2 – 3 2 – 3 2 – 3 2 – 3 2 – 3 2 – 3 2 – 3 2 – 3 2 – 3 2 – 3</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>D5596</td>
<td>every 2 rolls</td>
<td>Note 1 Note 1 Note 1 Note 1 Note 1 Note 1 Note 1 Note 1 Note 1</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT)</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100</td>
</tr>
<tr>
<td>Standard OIT, minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll Length, meters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll Width, meters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll Area, square meters</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

1. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3.

All values are minimum values unless stated otherwise. These specifications meet or exceed GRI GM-13 and are offered as an informational guide for consideration to assist engineers with their specifications. The values are not intended as a warranty or guarantee, and Sinotech Environmental Technologies Limited assumes no liability in connection with this information. Sinotech Environmental Technologies Limited reserves the right to change the specifications contained herein without notice.
Sinotech LLS Geomembranes
Linear Low Density Polyethylene (LLDPE) Smooth
Testing Frequencies and Properties

Sinotech LLS geomembranes are produced from prime linear low molecular weight (LLDPE) resins resulting in a high quality premium grade geomembrane with superior flexibility. Sinotech LLS has been formulated to be chemical resistant, free of leachable additives and resistant to ultraviolet degradation.

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Minimum Values for Sinotech LLS Geomembranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>D5199</td>
<td>every roll</td>
<td>0.45</td>
</tr>
<tr>
<td>Density (max.), g/ml</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.939</td>
</tr>
<tr>
<td>Tensile Properties (both directions)</td>
<td>D6693, Type IV</td>
<td>every 2 rolls</td>
<td>13</td>
</tr>
<tr>
<td>- Strength at Break, N/mm</td>
<td>G.L. 50mm</td>
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<td></td>
</tr>
<tr>
<td>- Elongation at Break, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% Modulus (max.), N/mm</td>
<td>D5323</td>
<td>every 2 rolls</td>
<td>210</td>
</tr>
<tr>
<td>Tear Resistance, N</td>
<td>D1004</td>
<td>every 2 rolls</td>
<td>50</td>
</tr>
<tr>
<td>Puncture Resistance, N</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>120</td>
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<tr>
<td>Axi-Symmetric Break Resistance Strain, %</td>
<td>D5617</td>
<td>90,000 kg</td>
<td>30</td>
</tr>
<tr>
<td>Carbon Black Content %</td>
<td>D1603</td>
<td>every 2 rolls</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>D5596</td>
<td>every 2 rolls</td>
<td>Note 1</td>
</tr>
</tbody>
</table>

Reference

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Nominal Values for Sinotech LLS Geomembranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>D5199</td>
<td>every roll</td>
<td>0.50</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT) Standard OIT, minutes</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Roll Length, meters</td>
<td></td>
<td></td>
<td>423</td>
</tr>
<tr>
<td>Roll Width, meters</td>
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<td>7</td>
</tr>
<tr>
<td>Roll Area, square meters</td>
<td></td>
<td></td>
<td>2,961</td>
</tr>
</tbody>
</table>

Notes:
1. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3.

All values are minimum values unless stated otherwise. These specifications meet or exceed GRI GM-17 and are offered as an informational guide for consideration to assist engineers with their specifications. The values are not intended as a warranty or guarantee, and Sinotech Environmental Technologies Limited assumes no liability in connection with this information. Sinotech Environmental Technologies Limited reserves the right to change the specifications contained herein without notice.
Tensiometer
Testing equipment used to determine tensile properties (ASTM D6693)
Introduction
The following tests are performed by our laboratory personnel in accordance with the standard test methods detailed in the indicated ASTM section unless otherwise noted, and are made for explanatory purposes only. The primary properties of the finished geomembrane is tested every other roll. Products must be sampled from every other roll. Samples must be taken even if they cannot be tested until a later date. Sampling is done by production personnel.

The following tests are performed on our textured sheet (double-sided and single-sided) at least once every other roll.

Thickness
- Thickness is determined in accordance with the procedures established in ASTM D 5994.
- Take a full width sample of sufficient length, exclude the inner and outer wraps of the roll or any material not representative of the sample.
- Remove test specimens from the laboratory sample in a randomly distributed pattern across the width, with no specimen taken closer than 15 cm to the roll edge.
- From each unit in the laboratory sample, remove the specimens so that the edge of the specimen will extend beyond the edge of the gage points by 10 mm in all directions.
- Take a number of test specimens per laboratory sample such that the user may expect, at the 95% probability level, that the test result is not more than 5% of the average above or below the true average of the sample.
- Bring the specimens to a temperature equilibrium of 21 ± 2°C and a relative humidity of 60 ±10%.
- Test the conditioned specimens in the standard atmosphere as described in the previous step.
- With the specified force applied directly to the pressure point on the base point (i.e., with no test specimen present), zero the measuring scale or record the initial non-zero reading.
- Lift the pressure point and insert the test specimen. While allowing the pressure point to come slowly into contact with the test specimen, adjust the test specimen to locate the gage points in the “low spot” or “valley” in between the projections, or into the indentations, of the textured surface(s) to obtain the local minimum thickness reading.
- Allow the full dead weight pressure to be applied for a minimum of 5 seconds, and record the thickness value to the accuracy of the gage.
- Repeat the method for each of the remaining specimens. Calculate the average thickness of the sample from the individual specimen results and record to the nearest 0.025 mm

Asperity Height
- The laboratory sample shall be the full roll width of the geomembrane under consideration. The length of the sample shall be such that the roll width lies flat on the supporting surface for proper measurement.
- Bring the specimens to a temperature equilibrium of 21 ± 2°C and a relative humidity of 60 ±10%.
- Without the sample, place the depth gage on a flat supporting surface so as to zero the indicator dial even with the bottom of the setting block.
- Place the depth gage on the surface of the textured sample so that the contact point rests within the depression region created by the texturing process.
- Place the depth gage on the surface of the textured sample so that the contact point rests within the depression region created by the texturing process.
- Take the reading from the dial indicator and record it to the closest 0.025 mm.
- Relocate the depth gage to the next position and repeat the process.
- Take ten (10) evenly spaced readings across the roll width of the sample. No readings should be taken closer than 300 mm to the roll edges.
- Calculate the average asperity value for the ten measurements as read directly from the dial indicator.

Tensile Properties
- Tensile Properties is determined in accordance with the procedures established in ASTM D6693.
- Die cut five (5) dumbbell shaped specimen with the length parallel to the machine direction and five (5) with the length perpendicular to the machine direction using an ASTM D 6693 Type IV die.
- Measure the width and thickness of rigid flat specimens in accordance with ASTM D5994.
- Insert the ends of the specimen into the jaws of the testing machine, aligning the long axis of the specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. The jaws should have an initial separation of 65 millimeters.
- Start the machine so the jaws separate at a rate of 50 mm/min.
- Continue separating the jaws until the specimen breaks.
- Calculate the strain at yield and break. Report in units of percent. A 33 millimeter gage length is used for yield calculation. A 50 millimeter gage length is used for break calculations.
Tear Resistance
- Tear Resistance is determined in accordance with the procedures established in ASTM D1004.
- Die cut ten (10) samples with the length parallel to the machine direction and ten (10) samples with the length perpendicular to the machine direction.
- Measure the thickness of the sample at several points.
- Place the sample in the grips of the testing machine so that the long axis of the sample is in align with the points of attachment of the testing machine.
- Apply a load of 51-mm (2-in.)/min rate of grip separation.
- After complete rupture of the sample, the maximum tearing load in pounds shall be noted from the dial scale or recorder chart and recorded.
- Report the average resistance to tearing for all samples and record in pounds.

Puncture Resistance
- Puncture Resistance is determined in accordance with the procedures established in ASTM D4833.
- Cut ten (10) samples with a minimum diameter of 100 mm (4 in.).
- Center and secure the sample between the holding plates of the testing apparatus.
- Test at a machine speed of 300 ± 10 mm (12 in. ± ½ in.)/min. until the puncture rod completely ruptures the test specimen.
- Read the puncture resistance from the greatest force registered on the recording instrument during the test.
- Report the results in units of pounds.

Stress Crack Resistance
- Stress Crack Resistance is determined in accordance with the procedures established in ASTM D5397.
- Die cut thirty (30) dumbbell shaped samples, each sample must be from one direction.
- Cut into each sample a control imperfection (notch) on one surface. The depth of the notch should produce a ligament thickness of 80% of the nominal thickness of the sample.
- Calculate the tensile force to be applied to each individual sample.
- Fill the test bath with reagent, and adjust the temperature to 50 ± 1°C (122 ± 2°F).
- Attach the sample to the hooks of the test apparatus.
- Immerse the samples and allow temperature equilibrium to be reached.
- Load each sample with its respective weight and record the elapsed time to failure to the nearest 0.1 hour.
- Report the test data in graphic form by plotting the logarithm of percentage yield stress versus the logarithm of the average failure time for each stress level.

Carbon Black Content
- Carbon Black Content is determined in accordance with the procedures established in ASTM D 1603.
- Place a weighed quantity of polyethylene in a 600 degree Celsius tube furnace with a flowing, oxygen free, nitrogen atmosphere.
- Allow the sample to remain in the furnace for fifteen (15) minutes. During this time all of the polyethylene should boil off leaving only the carbon black.
- Cool the carbon black for fifteen (15) minutes in a desiccator. Weigh.
- Report the results in units of percent.

Carbon Black Dispersion
- Carbon Black Dispersion is determined in accordance with the procedures established in ASTM D 5596.
- Select five samples randomly across the full roll width. Sample size should each be approximately 2.54 cm² (1 in.²).
- Using a microtome, prepare one thin section in the cross-machine direction from each sample. Each thin section should be (1) thin enough (8 to 20-µm thick) to allow for adequate light transmission and (2) free from major defects such as gouges caused by a nicked or dull knife, or such as torn or distorted portions of the thin sections caused by over-stressing or rough handling.
- Mount each excised thin section between a microscope slide and a cover glass, using a clear adhesive medium.
- Prepare the microscope for transmitting light microscopy with the calibrated reticle positioned between one eyepiece lens and the objective.
- Before attempting any close, microscopic examination of the thin section, place the mounted thin section on the microscope stage positioned between the light source and the objective.
- Place the overlay microscope slide on top of the mounted thin section so that each of the two circles on the overlay overlaps the thin section fully. The area within the circles is called a random field of view or (Rf).
- View the sample at 100X.
- Examine each Rf microscopically, and locate the largest carbon agglomerate or inclusion.
- Compare visually the microscope’s field of view containing the largest carbon agglomerate in the Rf with the carbon Adjunct D35) dispersion reference chart.
- Record the category that resembles that field of view most closely.
Oxidative Induction Time

- Oxidative Induction Time is determined in accordance with the procedures established in ASTM D3895.
- Compression mold a sample into sheet format (thickness of 250 ± 15 μm).
- Use a bore hole cutter to punch out a disk from the plaque and record the sample weight.
- Place the sample disk into the appropriate pan type.
- Prepare an empty sealed pan to be used as a reference.
- Turn on the nitrogen-gas flow at a rate of 50 mL/min (with an absolute pressure of 140 kPa).
- Adjust the temperature-calibration software to set the melting point at 156.63 and 231.97°C for indium and tin, respectively.
- Load the sample and reference pans into the instrument cell.
- Allow 5 min for a nitrogen prepurge prior to beginning the heating cycle to eliminate any residual oxygen.
- Commence programmed heating of the sample from ambient temperature to 200°C at a rate of 20°C/min.
- Commence programmed heating of the specimen from ambient temperature to 150°C at a rate of 20°C/min.
- Once the equilibrium time has expired, change the gas to oxygen at a flow rate of 50 ± mL/min. This is considered the zero time of the test procedure.
- Continue isothermal operation until 2 min have elapsed after the steepest point of the exotherm has been displayed.
- Plot the data with the heat flow signal on the y-axis, versus time on the x-axis.
- Report the results in minutes.

High Pressure OIT

- High Pressure OIT is determined in accordance with the procedures established in ASTM D5885.
- Cut several round samples 6.3 mm (0.25 in.) from the lab test sample.
- Compression mold these samples into a uniform plaque to a thickness of 0.25 mm (10 mil).
- Cut samples from the plaque using a 6.3 mm (0.25 in.) bore hole cutter or punch.
- Prepare a sample with a mass of 5 ± 1 mg.
- Place the weighed sample into a cleaned specimen pan.
- Place the sample and reference pans into the cell.
- Secure the top plate of the test chamber and tighten the cell system.
- Adjust the pressure release valve and the inlet valve of the cell.
- Adjust the pressure of the cylinder regulator to deliver 3.4-MPa (500-psi) test pressure.
- Slowly open the inlet valve of the cell and allow oxygen to purge the cell for 2 min.
- After 2 min, close the outlet valve, allow the cell to reach full pressure, then turn off the inlet valve and the oxygen supplied from the cylinder.
- Commence programmed heating of the specimen from ambient temperature to 150°C at a rate of 20°C/min.
- Zero time is taken at the initiation of the temperature program.
- Hold the temperature isothermally at 150°C until the oxidative exothermic peak is detected.
- At the same time, the thermal curve of the entire test is being recorded.
- Record the sample temperature 5 min after isothermal conditions have been reached.
- Terminate the test after the oxidative exothermal peak has passed through its maximum value.
- Plot the data with the heat flow signal on the y-axis, versus time on the x-axis.
- Report the results in minutes.

A visual inspection is made of the liner material to ensure that it is free of pores, pinholes, or other detrimental defects.

From the daily production testing, a quality certificate is issued by the laboratory.
Sinotech HDT Geomembranes

High Density Polyethylene (HDPE) Textured (double-sided)

Testing Frequencies and Properties

Sinotech HDT geomembranes are produced from high density polyethylene (HDPE) resins resulting in a high quality premium grade, flexible geomembrane. Sinotech HDT has been formulated to be chemical resistant, free of leachable additives and resistant to ultraviolet degradation.

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Minimum Values for Sinotech HDT Geomembranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinotech Product Code</td>
<td>D5994</td>
<td>every roll</td>
<td>0.71 0.95 1.43 1.90 2.38 2.85</td>
</tr>
<tr>
<td>Thickness (min. avg.), mm</td>
<td>D7466</td>
<td>every 2 rolls</td>
<td>0.25 0.25 0.25 0.25 0.25 0.25</td>
</tr>
<tr>
<td>Asperity Height¹, mm</td>
<td>D1004</td>
<td>every 2 rolls</td>
<td>93 125 167 249 311 374</td>
</tr>
<tr>
<td>Density, g/cc</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>240 320 480 641 801 948</td>
</tr>
<tr>
<td>Tear Resistance, N</td>
<td>D5397 (App.)</td>
<td>90,000 kg</td>
<td>2 - 3 2 - 3 2 - 3 2 - 3 2 - 3 2 - 3</td>
</tr>
<tr>
<td>Puncture Resistance, N</td>
<td>D1603</td>
<td>every 2 rolls</td>
<td>2 - 3 2 - 3 2 - 3 2 - 3 2 - 3 2 - 3</td>
</tr>
<tr>
<td>Stress Crack Resistance², hours</td>
<td>D5956</td>
<td>every 2 rolls</td>
<td>Note 3 Note 3 Note 3 Note 3 Note 3 Note 3</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>D5994</td>
<td>every roll</td>
<td>0.75 1.00 1.50 2.00 2.50 3.00</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT)</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100</td>
</tr>
<tr>
<td>Roll Length, meters</td>
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<td></td>
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<tr>
<td>Roll Width, meters</td>
<td>7 7 7 7 7 7</td>
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<tr>
<td>Roll Area, square meters</td>
<td>1,386 1,064 896 686 532 448</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Of 10 readings; 8 out of 10 must be ≥0.18 mm, and the lowest individual reading must be ≥0.13 mm.
2. The SP-NCTL test is not appropriate for testing geomembranes with textured surfaces. Tests should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
3. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3.

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Sinotech LLT Geomembranes
Linear Low Density Polyethylene (LLDPE) Textured
Testing Frequencies and Properties

Sinotech LLT geomembranes are produced from prime linear low molecular weight (LLDPE) resins resulting in a high quality premium grade geomembrane with superior flexibility. Sinotech LLT has either one or two co-extruded textured surfaces. Sinotech LLT been formulated to be chemical resistant, free of leachable additives and resistant to ultraviolet degradation.

### Minimum Values for Sinotech LLT Geomembranes

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>LLT 075</th>
<th>LLT 100</th>
<th>LLT 150</th>
<th>LLT 200</th>
<th>LLT 250</th>
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<tbody>
<tr>
<td>Thickness (min. avg.), mm</td>
<td>D5994</td>
<td>every roll</td>
<td>0.71</td>
<td>0.95</td>
<td>1.43</td>
<td>1.90</td>
<td>2.38</td>
<td>2.85</td>
</tr>
<tr>
<td>- Lowest indiv. for 8 out of 10 values</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.939</td>
<td>0.939</td>
<td>0.939</td>
<td>0.939</td>
<td>0.939</td>
<td>0.939</td>
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<tr>
<td>- Lowest indiv. of 10 values</td>
<td>D5617</td>
<td>90,000 kg</td>
<td>9</td>
<td>11</td>
<td>16</td>
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<tr>
<td>Asperity Height, mm</td>
<td>D7466</td>
<td>every 2 rolls</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Density (max.), g/ml</td>
<td>D1603</td>
<td>90,000 kg</td>
<td>70</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Tensile Properties (both directions)</td>
<td>D6693, Type IV</td>
<td>every 2 rolls</td>
<td>150</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
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<tr>
<td>- Strength at Break, N/mm</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
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<tr>
<td>- Elongation at Break, %</td>
<td>D5617</td>
<td>90,000 kg</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
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</tr>
<tr>
<td>2% Modulus (max.), N/mm</td>
<td>D5323</td>
<td>90,000 kg</td>
<td>370</td>
<td>420</td>
<td>630</td>
<td>840</td>
<td>1050</td>
<td>1260</td>
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<tr>
<td>Tear Resistance, N</td>
<td>D1004</td>
<td>every 2 rolls</td>
<td>70</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Puncture Resistance, N</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>150</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
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<td>Axi-Symmetric Break Resistance Strain, %</td>
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<td>every 2 rolls</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>D5596</td>
<td>every 2 rolls</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
<td>2 - 3</td>
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### Nominal Values for Sinotech LLT Geomembranes

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Nominal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>D5994</td>
<td>every roll</td>
<td>0.75</td>
</tr>
<tr>
<td>Standard OIT, minutes</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Roll Length, meters</td>
<td></td>
<td>198</td>
<td>152</td>
</tr>
<tr>
<td>Roll Width, meters</td>
<td></td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Roll Area, square meters</td>
<td></td>
<td>1,386</td>
<td>1,064</td>
</tr>
</tbody>
</table>

Notes:
1. Of 10 readings; 8 out of 10 must be ≥0.18mm, and the lowest individual reading must be ≥0.13mm.
2. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3.

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Sinotech HDM Geomembranes
High Density Polyethylene (HDPE) Textured (single-sided)
Testing Frequencies and Properties

Sinotech HDM geomembranes are produced from high density polyethylene (HDPE) resins resulting in a high quality premium grade, flexible geomembrane. Sinotech HDM has been formulated to be chemical resistant, free of leachable additives and resistant to ultraviolet degradation.

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Minimum Values for Sinotech HDM Geomembranes</th>
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<tr>
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<td></td>
<td>HDM 100</td>
</tr>
<tr>
<td>Sinotech Product Code</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness (min. avg.), mm</td>
<td>D5994</td>
<td>every roll</td>
<td>0.95</td>
</tr>
<tr>
<td>- Lowest indiv. for 8 out of 10 values</td>
<td></td>
<td></td>
<td>0.90</td>
</tr>
<tr>
<td>- Lowest indiv. of 10 values</td>
<td></td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>Asperity Height¹, mm</td>
<td>D7466</td>
<td>every 2 rolls</td>
<td>0.25</td>
</tr>
<tr>
<td>Density, g/cc</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.94</td>
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<tr>
<td>Tensile Properties (both directions)</td>
<td>D6693, Type IV</td>
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<td>11</td>
</tr>
<tr>
<td>- Strength at Break, N/mm</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>- Strength at Yield, N/mm</td>
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<td></td>
<td>150</td>
</tr>
<tr>
<td>- Elongation at Break, %</td>
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<td>- Elongation at Yield, %</td>
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<tr>
<td>Tear Resistance, N</td>
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<td>every 2 rolls</td>
<td>125</td>
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<td>Puncture Resistance, N</td>
<td>D4833</td>
<td>every 2 rolls</td>
<td>320</td>
</tr>
<tr>
<td>Stress Crack Resistance², hours</td>
<td>D5397 (App.)</td>
<td>90,000 kg</td>
<td>400</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>D1603</td>
<td>every 2 rolls</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>D5596</td>
<td>every 2 rolls</td>
<td>Note 3</td>
</tr>
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<table>
<thead>
<tr>
<th>Reference</th>
<th>ASTM Test Method</th>
<th>Frequency</th>
<th>Nominal Values for Sinotech HDT Geomembranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>D5994</td>
<td>every roll</td>
<td>1.00</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT)</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Standard OIT, minutes</td>
<td></td>
<td></td>
<td>152</td>
</tr>
<tr>
<td>Roll Length, meters</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Roll Area, square meters</td>
<td></td>
<td></td>
<td>1,064</td>
</tr>
</tbody>
</table>

Notes:
1. Of 10 readings; 8 out of 10 must be >0.18mm, and the lowest individual reading must be >0.13mm.
2. The SP-NCTL test is not appropriate for testing geomembranes with textured surfaces. Tests should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
3. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3.

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Density Column
Testing equipment used to determine density properties (ASTM D1505 or ASTM D792)
华忠（青岛）环境科技有限公司

生产质量保证政策及程序

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1.1 须知
本手册旨在介绍华中（青岛）环境科技有限公司质量控制及质量保证的理念，并设立程序，规范为提供客户所需产品与服务时所采取的合理方法。同时，为符合公司对于系统化程序的需要，此程序由组织内积极、高效的质量控制部门来实施。

2.1 生 质量保证政策
Sinotech的质量控制政策将坚持最高的质量标准，每一个员工都应始终贯彻所有已公布的质量控制标准。质量保证的态度必须在所有员工中普及，而这种态度，辅以强有力的质量控制程序，将成为高质量产品的保证。

Sinotech质量控制与研发实验室将实施并行实验来保证对所有产品的控制。同时，实验室还能支持生产、产品开发及研究需求。为此，华中公司会雇佣来自工人及存档人员的质量保证建议，同时也欢迎来自客户的建议。

我们的质量控制程序是一个连贯性系统，用来对生产出的材料进行管理和测试。质量控制部门保留拒绝不符合Sinotech规格的原料或材料的权利。

我们的质量保证对相关已进行的培训、生过程、质量控制测试、材料处理、数据核实以及分销的程序进行核查。包括核查测试结果的有效性，测试程序的正确性以及对测试仪器的合理操作。

这些程序适用于所有且必须始终贯彻，并至少每年更新一次，之后至少每年对符合的程序整理一次。这将取代之前所有与质量控制相关的程序。

1.3 质量保证实验室
Sinotech的质量控制实验室设备齐全，可以进行广泛的土工膜产品一致性测试。样品均由专用模具切割，在保证样品的统一性的同时，确保符合ASTM的要求。对于不符合ASTM标准的标本不予采用。所有质量控制实验结果将被存储在电脑数据库，以备检索。

1.4 实验设备维护
所有实验设备需定期检查并进行适当校正。插入设备为自动校正，校验序列在每次实验开始时设定。实验室所有拉伸测试仪器由独立机构根据ASTM E-4标准，每年维护一次。并对机器进行例行检查，以保证正常的操作条件。

1.5 材料质量保证
我们的实验包括短期实验，旨在识别提供原料的“指纹”。每种树脂都有它的特性，这种特性是由其化学成分与分子重量决定的。例如，密度和熔融指数可以用来帮助辨别材料，从而决定是否采用。同时也会对污染物进行目测。

1.5.1 原料测试
Sinotech制定了每批原料必须符合的标准参数。原料供货商必须承诺遵循这些参数。供货商需对每批原料进行参数实验，实验结果将提交Sinotech实验室，并由实验室通过相应实验核实。

每批装箱树脂（33,000 lbs.）只有经过Sinotech实验室实验，并确认其质量符合Sinotech已设立参数，方可卸货。实验包括密度、溶体流动指数和挥发量。所有未经核实的材料将被立即分开，并通知供货商。同时通知所有部门，提升运/收货人；准备退货商商谈原料所必须的文字材料。

与材料核实一致，有关材料装箱和使用的正式文件已颁布。进入加工的树脂将由质量控制部门进行不间断的管理。

1.5.2 机生质量保证
我们的光面膜是基以进行式基础进行管理的。在土工膜的生过程中，会不断从整个膜上采用厚度数据。这些数据将被用来决定每卷的厚度、厚度以及平均厚度；通过对成的取样厚度测试进一步确定这些厚度值。

粘面膜也是基于进行式基础管理的。在土工膜的生过程中，会不断从整个膜上采用厚度数据。此数据将被用来决定每卷的厚度、厚度以及平均厚度；通过对成的取样厚度测试进一步确定这些厚度值。要到至少每两卷膜的生进行标准测试（拉伸性、厚度、碳黑分散度等，以及目测）。
1.5.3 火花实验
在每条生线上都装有一个电火花探测器。它可以对成卷上的孔做出迅速警示。一旦发现有洞，会触发警报，从而确定孔的位置。有洞的卷将被立即驳回并从标准品库存中移出。

1.6 材料识别
所有成卷将被贴上两个自粘贴纸标签。一个贴在卷头明显的地方，另一个贴在第一层膜下方。且方向相反的卷尾。当装运材料时，我们将对标签进行记录用来进行质量控制认证。卷的装运将用吊车或叉车来进行，具体取决于客户所要求的运输方式，但需采用40尺标准集装箱或开顶集装箱。

用刻印标记挤压棒，并人工刻在在卷筒尾部的标签上。在装运挤压卷时，装运人员记录棒号、生移和棒重。此信息将交质量控制部门，用做认证。挤压棒袋装运输。

1.7 记录保留
每生一卷，都会从上面切取一个样品，分类并保存至少5年。

实验结果出来后，将被马上输入SINOTECH实验室数据库，并通过它总览所有质量控制证书。对数据库进行每日备份，以确保所有数据的留用。同时，数据库也可以汇总报告具体定单、项目、材料种类、生日期、厚度以及树脂批量号码等。完善实验结果和数据控制报告以备客户索取。

另外，对于已完成的样品数据，所有树脂供应商质量保证文件，SINOTECH树脂测试报告和树脂样品都将被保存5年。

1.8 实验室技术员计划
有生任务时，SINOTECH实验室都将配备工作人员，保证每天24小时，全年365天有人职守。这可以最大限度减少发现问题之前，不符合标准的材料被用于加工。
简介
对于运抵我方青岛工厂的国 材料，如果没有经过测试，或测试未取得满意的实验结果，将一律不予采用。要对每5000kg收到的树脂进行如下实验。

密度
- 根据ASTMD1505测试法中已有的对应程序来检测密度。
- 将密度仪槽盖轻轻打开，勿使密度仪 生震动。
- 用铁夹取一个样品，并轻轻放入密度仪槽内，注意勿使样品附着气泡，如果样品附着气泡，可再取一样品轻轻放入，或将样品以密度相似的溶液浸泡后，再将样品轻轻放入。
- 将密度仪槽盖轻轻盖上，勿使密度仪震荡。
- 此时样品慢慢下沉，约15—20分钟左右，待样品静止。
- 记录样品静止的刻度位置。
- 以其刻度值对照密度与刻度的斜率图，查出样品的密度值。
- 判定：1)高密度聚乙烯样品经实验室检验后的密度值在0.935g/mm3以上，为合格。2)低密度聚乙烯样品经实验室检验后的密度值在0.935g/mm3以下为合格。
- 计算密度并以“克/立方公分”为单位作出结果报告。

融体流动指数
- 通过ASTMD1238-Condition E中对应的程序去确定融体流动指数。
- 将融体计加热到190℃。
- 将3.7克树脂加入融体计的气缸里，聚拢树脂，加入活塞，放2.06克重量到活塞里。
- 放开融体计。当活塞对面，气缸的一端有一直径为0.0825英寸的孔。在最后8分钟移去所有通此孔被挤压过的塑料。
- 使融体计再停止10分钟。在实验阶段将要结束时，移开受挤压过的塑料，并在实验室条件下冷却。
- 衡量挤压，并以克/10分钟为单位报告实验结果。

碳黑含量
- 通过ASTMD1603中对应的已有程序来确定碳黑含量。
- 用已称重的聚乙烯在600℃高温并有流动无氧氮气氛后炉内。
- 保持样品在炉内5分钟。在此期间，所有的聚乙烯将燃烧，只剩下碳黑。
- 在干燥器里将碳黑冷却15分钟。
- 秤并计算剩余碳黑的百分比。
- 以百分比为单位报告结果。

氧化诱导时间
- 通过ASTMD3895中对应的已有程序来确定氧化诱导时间。
- 用模具压模样品为薄薄膜样式（厚度为250 1 5微米）。
- 用喷头在金属板上穴出一片磁盘状样品并记录其重量。
- 将样品放置在适当型号的选矿锅内。
- 准备一个空的已加工的选矿锅做参照。
- 将样品及参照选矿锅放入 chambers。
- 打开氮气流，并控制在50ml/分钟（绝对压力为140kpa）。
- 调整温度校正软件，将indium和锡的熔化点分别设置为156.63和231.97℃。
- 将样品和参考锅放入仪器仓里。
- 开始循环加热前，用5分钟时间冲入氮气，已除去所有残留氧气。
- 通常设定通过加热周围空气加热样品，加热速率为20℃/分钟，直到加热到200℃。
- 当加热到即定温度时，中断已设定的加热程序，在已设定温度下使样品恒温五分钟。
• 当完成恒温阶段后，将气体更换为氧气，流动率为50 m l/分钟。这被认为是测试程序的零时间点。
• 持续等温操作两分钟，直到放热曲线的最深点已经显现出来。
• 用热流标记将看到的数据标在Y轴上，与其相对的时间标在X轴上。
• 已分为单位报告结论。

一旦确认了原料符合生产指标，树脂将通过管道由集装箱输送到其指定的专有桶仓里。所有不符合方案标准的将退还供应商。
### Sinotech天然树脂最低测试频率

<table>
<thead>
<tr>
<th>性能</th>
<th>测试方法</th>
<th>自然树脂</th>
</tr>
</thead>
<tbody>
<tr>
<td>密度</td>
<td>ASTM D1505</td>
<td>每集装箱一次</td>
</tr>
<tr>
<td>熔体流动指数</td>
<td>ASTM D1238 (190/2.16)</td>
<td>每集装箱一次</td>
</tr>
<tr>
<td>氧化诱导期</td>
<td>ASTM D3895 (1 atm @ 200°C)</td>
<td>每批次树脂一次</td>
</tr>
<tr>
<td>碳黑含量</td>
<td>ASTM D1603, 修正版</td>
<td>无</td>
</tr>
<tr>
<td>碳黑分散度</td>
<td>ASTM D5596</td>
<td>无</td>
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</tbody>
</table>

备注：所有程序和数值均可能变动，并无须事先通知。

### Sinotech天然树脂最低性能

<table>
<thead>
<tr>
<th>性能</th>
<th>测试方法</th>
<th>HDPE</th>
<th>LLDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>密度， g/m³</td>
<td>ASTM D1505</td>
<td>0.932</td>
<td>0.915</td>
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<tr>
<td>溶体流动指数， g/10min</td>
<td>ASTM D1238 (190/2.16)</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
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<tr>
<td>氧化诱导期，分钟</td>
<td>ASTM D3895 (1 atm @ 200°C)</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

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光面膜测试

简介
如下实验由我方实验室人员操作，如无特别说明，将根据ASTM中对应部分所详细说明的标准测试方法进行。且仅做解
释用。将在每两卷膜中选一卷进行成品土工膜的主要特性测试。即使以后才能进行测试，也必须取样。取样由生
人员进行。

将在每两卷平面膜中选一卷进行如下测试。

厚度
- 厚度将根据ASTM D5199中已有的对应程序来确定。
- 对于实验室采样，沿布的边或卷的边缘取全宽且足够长的样品。
- 从实验室采样上取宽度相同，随意样式的实验样品，但在距离边缘152mm（6英寸）内不取样。
- 从实验室采样上取下所有试验样品，使样品的边缘从各个方向延伸至压力脚边缘外10毫米（6英寸），这样至少
是一个直径为75毫米（3英寸）的圆。
- 调整基台上的压力脚（现在无试验样品），使测量天平归零，或记录“基本读数”。
- 拿起压力脚，将试验样品置于压力脚下基台的中间，然后使压力脚和材料连接。逐渐增加压力到20 kPa (2.9
psi)。
- 使所有作用力都作用于紧贴试验样品的压力脚上并持续5秒钟，记录厚度值且厚度值相差需小于0.02毫米。从
测试仪上移去样品。
- 对于剩余试验样品，重复如上所述测试方法。
- 根据试验仪器上的直接读数，计算所有实验结果的平均厚度。
- 报告平均厚度。

最低拉伸性能
- 最低拉伸性能将根据ASTM D6693中已有的对应程序来确定。
- 在样品完成后，以每两卷标准卷中取出一卷。由生人员取一片与生方向垂直长30mm宽20mm左右的样品，并注明
编号。
- 通过ASTM D5199对应的方法，测量严格平滑试验品的宽度及厚度。测完后由实验室人员拿回做实验。
- 将样品放入压模机的压模平台上。
- 取出ASTM D6693Type I及ASTM D1004D six G两种模具。
- 将模具刀口朝下平稳放在样品上，勿使模具倾侧或倾斜，以免压模时造成模具变形或损坏。
- 在样品表面直线刻横的平行与垂直方向，即与生方向平行与垂直的方向，用两种模具压制试验样品。
- 于拉力机前的桌面，将检测撕裂的样品置于最低下，将试验样品置于其上。并以样品批号将样品由右而左依次
排列整齐。
- 将样品置于拉力机夹具中间，且与拉力机夹具保持垂直，再以拉力机夹具夹住样品上下两边，夹住部分的面积
应相等，铁夹中间样品的形状、面积也应对称相等。
- 连接电脑，打开对应程序并进行操作。
  - 在测试方法里输入ASTM D6693。
  - 在测试方法里输入品名称，厚度，宽度，面积，夹距，标距。
  - 在测试方法里输入测试批号、检测人员、客户名称、试品材质、测试方向。
  - 拉力机即开始进行拉力检验。
  - 当拉力机将样品拉断后，拉力检验完成，显示器将检验值以数值及图形显示。
  - 于样品表面直线刻横的平行与垂直方向，各作拉力检验，并计算检验结果的平均值。
  - 根据电脑显示器上读数，记录试验样品的屈服强度和断裂强度，并以牛顿为单位报告结果。

抗拉强度
- 通过ASTM D1004测试法中已有的对应方法，测量抗拉强度。
- 用模具切出10块样品，其长度与机器方向平行；用模具切出另外10块样品，其长度与机器方向垂直。
- 取点测量样品的厚度。
光面膜测试

- 将试验品置于拉力机夹具正中间，并与其保持垂直，然后用夹具夹住样品上下两面。样品被夹住的面积应相等，夹具中间的样品形状、面积也应相等。
- 操作连线电脑打开程序进行操作。
  - 在测试方法里面输入ASTM D1004
  - 在试验样品资料里输入样品名称、厚度、宽度、面积、夹距和标距。
  - 在测试资讯里面输入测试批号，检测人员，客户名称，试品材质，试品方向。
  - 拉力机即开始操作抗拉伸检验。
  - 当样品被完全拉断后，拉力检测完成，显示器将检验值以数值及圆形显示出。
  - 于样品表面刻痕的平行与垂直方向，各作拉力检验，并计算样品检验的平均值。
- 根据显示器读数，记录试验样品的屈服强度和断裂强度，并以牛顿为单位报告结果。
- 总结所有样品的平均抗拉强度并以牛顿单位记录。

抗拉穿性
- 通过ASTM D4833中对应的方法，测定抗拉穿力。
- 切10块直径最小为100毫米（4英寸）的样品。
- 取下拉力机上下夹具，换上铜棒与夹板棒，锁紧螺丝，以防止晃动。
- 将样品置于试验仪器的金属夹板棒之间并固定。
- 连接电脑并根据对应程序进行操作。
  - 在测试方法里面输入ASTM D4833。
  - 在试验样品资料里输入样品名称、厚度、宽度、面积、夹距和标距。
  - 在测试资讯里面输入测试批号，检测人员，客户名称，试品材质，试品方向。
  - 拉力机即开始操作抗拉穿性检验。
  - 当拉力机将样品完全穿刺后，铜棒自动退回原点，抗拉穿性检验完成。显示器将检验值以数值及圆形显示出。
- 根据显示器上所显示的数值，读出抗拉穿力。
- 以牛顿为单位报告试验结果。

恒定拉伸负荷应力开裂
- 通过ASTM D5397中对应的方法，测定恒定拉伸负荷应力开裂。
- 用模具切30块哑铃样样品，每块样品方向不同。
- 在所有样品的表面之一刻上控制刻痕，刻痕的深度达到允许生厚度为正常样品厚度80%的韧带刻痕。
- 计算将作用于每个独立样品上的拉力的大小。
- 将反应力充满测试槽，并调整温度到50 1 °C（122 2 °F）。
- 将样品附着到试验仪器的钩钩上。
- 浸入样品，并允许温度均衡接近。
- 加载每个样品的分别重量并记录不足0.1小时的已花费时间。
- 通过制每个应力层上的屈服应力百分比对数以及与其对应的平均时间，以图解方式记录试验数据。

碳黑含量
- 通过ASTM D1603中对应的方法，测定碳黑含量。
- 将已称重量的色母放进温度达到600℃的管炉里，炉里为无氧流动氮气层。
- 使样品在管炉里保持15分钟。在此期间，所有的色母都将被蒸发，仅余留残留物碳黑。
- 在干燥器中冷却碳黑15分钟并称重。
- 以百分比为单位记录结果。

碳黑分散度
- 通过ASTM D5596中对应的程序，测定碳黑分散度。
  - 从标准卷宽度上随机选取5个样品。每个样品最大尺寸2.54cm2（1平方英寸）。
  - 使用显微镜用薄片切片机，在样品的每个机器交叉方向各准备1个薄片。所有薄片应达到：（1）足够厚度（8-20微米厚），允许进行充分光线传导；（2）无严重缺陷，如由齿刀或齿轮刀所导致的圆凿，或是由于过度挤压或随意放置所引起的薄片部分的扭曲。
光面膜测试

- 浸好在显微镜片和防护玻璃罩之间的每一个已切割的薄片，使用干净的沾合剂介质。
- 准备用于观察细微的且刻痕已校正的显微镜，刻痕位于目透镜和物体之间。
- 在对薄片进行任何近距离、细微物检查前，将浸的薄片放到已固定在光线和物体之间的显微镜台上。
- 将显微物镜滑片置于已浸好的薄片上，这样使覆盖物上的两个物镜都完全与薄片交迭。圈内部分即是任意视觉区（或参照）。
- 放大100倍后观察样品。
- 用显微镜比较每个参照系，定位最大的碳黑团或碳黑包含物。
- 通过目测比较显微镜下包含最大碳黑团的可视区域，并参照碳黑附D35分散参照图。
- 记录与此区域最接近的类型。
- 重复上述程序直到10个类似读数都记录。从每个薄片上最多取2个参照数，而薄片数需不少于5个。
- 记录每个可视区域的分类。

氧化诱导期
- 通过ASTM D3895中对应的程序，测定氧化诱导期。
- 压膜样品成为薄片样式（厚度250±5微米）。
- 用穿孔刀从薄膜金属板上打孔并穴出一块圆板，记录样品的重量。
- 将样品板放入适当型号的面板中。
- 准备一块空的已铝封的面板作为参照。
- 将试验样品及参照面板放入仪器仓。
- 在50ml/分的速率下打开氮气流（绝对压力为140 kPa）。
- 温度校正软件，设定铝和锡的熔点分别为156.63和231.97℃。
- 将样品和参照面板装进仪器仓。
- 开始循环加热前用3分钟时间注入氮气，以排除残留的氧气。
- 开始根据已设定程序，以20℃/分的速率从常温加热样品到200℃。
- 当温度达到时，中断加热程序，使样品在设定温度下均温5分钟。
- 一旦均温时间已完成，将气体改变为流动率50 ml/分的氧气。这就是试验程序的零点。
- 继续等温操作直到达到2分钟时间，而此时放热曲线的最深点已经显现出来。
- 将数据和热流标志一起到Y轴上，将时间到X轴上。
- 以分为单位记录结果。

高压OIT
- 通过ASTM D5885中对应的程序，测定高压OIT。
- 从实验室样品中切取几个6.3mm（0.25英寸）的圆形样品。
- 用压膜将这些样品压制成统一的薄片，厚度为0.25mm（10密耳）。
- 用6.3mm（0.25英寸）的穿孔刀或穴刀从薄片上切取样品。
- 准备一个最大厚度为51毫克样品。
- 将称重后的样品放入已清洁的实验样品锅里。
- 将样品及参照锅放入仪器仓。
- 固定测试室的顶部金属板，并收紧仪器仓系统。
- 关闭压力，释放电子阀及仪器仓的入口阀。
- 调整气缸的压力，使其均衡的提供3.4-Mpa（500-psi）的测试压力。
- 慢慢打开仪器仓的入口阀，以用氮气净化仪器仓2分钟。
- 2分钟后，关闭出口阀，使仓内达到全压，接着关掉入口阀以及气缸的氧气供应。
- 开始已定的试验样品加热程序，并以20℃/分钟的速率从常温加热到150℃。
- 在温度程序开始时记录零点时间。
- 保持温度在150℃恒温直到探测出氧化发热的峰值。
- 同时，整个试验的热量曲线将被记录。
- 当达到恒温条件5分钟后记录样品温度。
- 当氧化发热的峰值超过它的最大值后，结束试验。
- 在X轴上用热流标示出此数据，对应的在X轴上出时间。
以分钟为单位报告结论。

对衬里材料的视觉检验是为了确保材料无小孔、针孔或其他有害的缺陷。

从每日生产试验中，将由实验室给出质量证书。
### Sinotech高密度聚乙烯光滑面土工膜
#### 高密度聚乙烯[HDPE]光滑面
测试频率及性能

*Sinotech*华忠光滑面土工膜由高密度聚乙烯[HDPE]树脂制成，使土工膜产品具有优异的品质和良好的韧性。其制造配方使之具有优秀的抗化学腐蚀能力、无添加剂析出和抗紫外线老化的优点。

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华忠高密度聚乙烯光滑面土工膜最低值</th>
</tr>
</thead>
<tbody>
<tr>
<td>厚度，mm</td>
<td>D5199</td>
<td>每1卷一次</td>
<td>HDS 030 HDS 050 HDS 075 HDS 100 HDS 150 HDS 200 HDS 250 HDS 300</td>
</tr>
<tr>
<td>密度，g/cc</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.94 0.94 0.94 0.94 0.94 0.94 0.94</td>
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<tr>
<td>最低拉伸性能(两个方向)</td>
<td>D6693，IV型</td>
<td>每2卷一次</td>
<td>8 15 21 28 43 57 71 85</td>
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<tr>
<td>- 断裂强度，N/mm</td>
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<td>5 8 11 15 23 30 38 45</td>
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<tr>
<td>- 屈服强度，N/mm</td>
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<tr>
<td>- 屈服延伸率，%</td>
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<tr>
<td>抗拉强度，N</td>
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<td>每2卷一次</td>
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<td>D4833</td>
<td>每2卷一次</td>
<td>105 176 263 400 530 703 881 1059</td>
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<tr>
<td>恒定拉伸符合应力开裂,小时</td>
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<tr>
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<tr>
<td>碳黑分散度</td>
<td>D5596</td>
<td>每2卷一次</td>
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### 参考

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华忠高密度聚乙烯光滑面土工膜常规值</th>
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<tr>
<td>厚度，mm</td>
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<td>HDS 030 HDS 050 HDS 075 HDS 100 HDS 150 HDS 200 HDS 250 HDS 300</td>
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<tr>
<td>氧化诱导期(OIT)</td>
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<td>标准OIT,分钟</td>
<td></td>
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<td>200 423 282 211 141 106 85 70</td>
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<td>卷长,米</td>
<td>7 7 7 7 7 7 7 7</td>
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<td>1,400 2,961 1,974 1,477 987 742 595 490</td>
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</table>

注释：
1. 碳黑分散度（仅球型团周围）。取10个不同数值：
   - 至少9个属于类型1或2。1个属于3类。
2. 这些数据均为最低值（特别说明的除外）。上述规格达到或已超过了“土工合成材料学会（美国GRI）”的GM-13标准，并作为国际性的技术指南，以协助工程技术人员。在这里印印的数据不单独作为使用的担保或保证，华忠公司对于技术指标的责任将明确在合同中。华忠公司有可能改进这些规格但不再另行通知。
**Sinotech 低密度聚乙烯光滑土工膜**

**线性低密度聚乙烯(LLDPE)光滑面**

测试频率及性能

Sinotech华忠的LLS土工膜是以最好的线性低密度聚乙烯(LLDPE)为主要原料制造，因此成为具有极高品质的超柔性土工膜；所生产的生产配方使其具备抗化学腐蚀、无添加剂析出和抗紫外线老化的优良性能。

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
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<td>厚度, mm</td>
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<td>G.L.</td>
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<td>2%膜厚（最大）, N/mm</td>
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<td>抗拉强度, N</td>
<td>D1004</td>
<td>每2卷一次</td>
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<td>抗戳穿力, N</td>
<td>D4833</td>
<td>每2卷一次</td>
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<td>轴对称拉伸断裂面</td>
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<td>碳黑含量, %</td>
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<tr>
<td>碳黑分散度</td>
<td>D5596</td>
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<td>注释1</td>
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参考

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<th>频率</th>
<th>Sinotech光华面土工膜标准值</th>
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<td>卷面积, 平方米</td>
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注释：
1. 碳黑分散度（仅球型团周围），取10个不同数值。
   - 至少9个属于类型1或2，1个属于3类。

这些数据均为最低值（特别说明的除外）。上述规格达到或已超过了“土工合成材料学会（美国GRI）”的GM-13标准，并作为国际性的技术指南，以协助工程技术人员。在这里所列的数据不单独作为特惠的担保或保证。华忠公司对于技术指标的责任将根据在合同中。华忠公司有可能改进这些规格但不再另行通知。
光面膜测试

压力机
用于测定最低拉伸性能的试验仪器（ASTM D6693）
简介

如下实验由我方实验室人员操作，如无特别说明，将根据ASTM中对应对应部分所详细说明的标准测试方法进行。且仅做解释用。将在每两卷膜中选一卷进行成品土工膜的主要特性测试。即使以后才能进行测试，也必须取样。取样由生人员进行。

将在每三卷糙面膜（双面和单面）中选一卷进行如下测试。

厚度

- 厚度将根据ASTM D5199中已有的对应程序来确定。
- 取标准卷宽且足够长的样品，但不能取卷里或卷外的包装卷，也不能取任何无法代表样品的材料。
- 从实验室采集的标准卷宽上取随意样式的实验样品，但在距离边缘15cm内不取样。
- 从实验室采集上拿去所有试验样品，将使样品的边缘从各个方向延伸至压力脚边缘外10毫米(6 英寸)。
- 根据需要从实验室采集上取几块试验样品，95%的试验结果应不超过样品平均值或平均值的5%。
- 将试验样品放到21±2℃的恒温下，相对湿度为60±10%。
- 如前所述在标准空气中对取样试验样品进行测试。
- 将特殊作用力直接作用于位于基台上的压力点上（也就是现在没有试验样品），将测量计归零或记录初始非零点读数。
- 抬起压力点，插入样品。当压力点与试验样品逐渐连接时，调整样品测量点处于发射“低点”或“高点”，或使其位于糙面的凹痕里，测得此处的最厚厚度读数。
- 使全部绝对测量作用至少5秒钟，根据度量计上的精确值记录厚度值。
- 用同样方法对所有剩余样品进行测试。根据每个独立样品的测试结果计算样品的平均厚度，记录测试值且最低值相差最小为0.025mm。

粗糙高度

- 试验采样必须与所选土工膜的标准卷宽相同。长度的要求是可以保证所有卷宽平放在支撑面上，便于适当的测量。
- 将试验样品置于21±2℃的恒温环境下，相对湿度为60±10%。
- 移去样品，将高度测量计放到平板支撑面上。此时即使在设置区的底部，也可以使指示刻度盘归零。
- 将高度测量计放置到糙面膜的表面上，使连接点处于生糙面时所形成的低压区里。
- 根据刻度盘指针读取读数，记录测试值且最低值相差最小为0.025mm。
- 重复试验数仪到下一个位置并重复上述程序。
- 从样品的标准卷宽上取十个平均间距的读数。在卷边缘300mm以内的地方不取任何读数。
- 根据十次测量中刻度指针的直接读数，计算平均粗糙高度值。

最低拉伸性能

- 最低拉伸性能将根据ASTM D6693中已有的对应程序来确定。
- 在样品完成后，以每两卷标准卷中取出一卷。由生人员取一片与生方向垂直长30mm宽20mm左右的样品，并注明卷号。
- 通过ASTM D5199对应的方法，测量严格平滑试验样品的宽度及厚度。测完后由实验室人员拿回做实验。
- 将样品放于压模机的压模平台上。
- 取出ASTM D6693 Type IV及ASTM D1004 Die C两种模具。
- 将模具刀口朝下平放在样品上，勿使模具倾倒或是倾斜，以免压模时损伤模具变形或损坏。
- 在样品表面上涂上一层色料的平行与垂直方向，即与生方向平行于垂直的方向，用两种模具压制实验样品。
- 于拉力机前的桌面，将检测撕裂的样品置于最低下，将试验样品置于其上。并与样品批号将样品由右而左依次排列整齐。
- 将样品置于拉力机夹具中间，且与拉力机夹具保持垂直，再以拉力机夹具夹住样品上下两边，夹住部分的面积应相等，铁夹中间样品的形状，面积也应对称相等。
糙面膜测试

- 连接电脑，打开对应程序并进行操作。
  - 在测试方法里输入ASTM D6693。
  - 在试验资料里输入：名称，厚度，宽度，面积，夹距，标距。
  - 在试验信息里输入：试验批号，检测人员，客户名称，试验日期，试验方向。
  - 拉力机开始进行拉力检验。
  - 当拉力机将样品拉断后，拉力检验完成，显示器将检验值以数值及图形显示。
  - 于样品表面，观察到的不规则形和尺寸方向，各作拉力检验，并计算检验结果的平均值。
- 根据电脑显示器上读数，记录试验样品的屈服强度和断裂强度，并以牛顿为单位报告结果。

抗拉强度
- 通过ASTM D1004测试法中已有的对应方法，测量抗拉强度。
- 用膜具切出10块样品，其长度与机器方向平行；用膜具切出另外10块样品，其长度与机器方向垂直。
- 取点测量样品的厚度。
- 将试验品置于拉力机夹具正中间，并与其保持垂直，然后用夹具夹住样品上下两边。样品被夹住的面积应相等，夹具中间的夹具形状、面积也应相等。
- 操作连线电脑打开程序进行操作。
  - 在测试方法里输入：ASTM D1004。
  - 在试验样品资料里输入：名称，厚度，宽度，面积，夹距和标距。
  - 在试验信息里输入：试验批号，检测人员，客户名称，试验日期，试验方向。
  - 拉力机开始操作抗拉伸检验。
  - 当样品被完全拉断后，拉力检验完成，显示器将检验值以数值及图形显示出。
  - 于样品表面，观察到的不规则形和尺寸方向，各作拉力检验，并计算样品检验的平均值。
- 根据显示器上读数，记录试验样品的屈服强度和断裂强度，并以牛顿为单位报告结果。
- 总结所有样品的平均抗拉强度并以牛顿为单位记录。

抗弯强度
- 通过ASTM D4833中对应的方法，测量抗弯强度。
- 切10块直径最小为100毫米（4英寸）的样品。
- 取下拉力机上下夹具，将上部与夹板，锁紧螺丝，以防止晃动。
- 将样品置于试验仪器的金属夹板之间并固定。
- 连接电脑并根据对应程序进行操作。
  - 在试验方法里输入：ASTM D4833。
  - 在试验样品资料里输入：名称，厚度，宽度，面积，夹距和标距。
  - 在试验信息里输入：试验批号，检测人员，客户名称，试验日期，试验方向。
  - 拉力机开始操作抗弯性检验。
  - 当样品弯曲到分度时，抗弯性检验完成。显示器将检验值以数值及图形显示出。
- 容据电脑显示器上显示的数值，读出抗弯强度。
- 以牛顿为单位报告试验结果。

恒定拉伸负荷应力开裂
- 根据ASTM D5397中已有方法，测量恒定拉伸负荷应力开裂。
- 用模具切30块哑铃状样品，每块样品方向不同。
- 在所有样品的表面之一刻上控制刻痕。刻痕的深度达到允许生厚度为正常样品厚度80%的韧带刻痕。
- 计算将作用于每个独立样品上的拉力的大小。
- 将反应力充满测试槽，并调整温度到50°C（122°F）。
- 将样品附着到试验仪器的挂钩上。
- 浸入样品，并允许温度均衡接近。
- 加载每个样品的分别重量并记录不足0.1小时的已花费时间。
- 通过制每个应力层上的屈服应力百分比对数以及与其对应的平均时间，以图解方式记录试验数据。
糙面膜测试

碳黑含量

- 根据ASTM D1603中的已有方法，测定碳黑含量。
- 将已称重量的色母放入温度达到600℃的烘箱里，烘箱为无氧流动氮气层。
- 使样品在烘箱内保持15分钟。在此期间，所有的色母都将被蒸发，仅余留残留物碳黑。
- 在干燥器中冷却碳黑15分钟并称重。
- 以百分比为单位记录结果。

碳黑分散度

- 根据ASTM D5959中已有的程序，测定碳黑分散度。
- 从标准卷宽度上随机选取3个样品。每个样品最大尺寸2.54cm²（1平方英寸）。
- 使用显微镜用薄片切片机，使样品的每个切片交叉方向各准备1个薄片。所有薄片应达到：（1）足够厚度（8-20微米厚），允许进行光学读数；（2）无严重缺陷，如有油迹或钝刀所不平的圆角，或是由于过度挤压或未得到的引起的薄片部分的扭曲。
- 胶好在显微镜片和防护玻璃罩之间的每一个已切割的薄片，使用干净的沾合剂介质。
- 准备用于观察细微的且刻痕已校正的显微镜，刻痕位于目镜镜片和物体之间。
- 在对薄片进行任何远距离、微小物检查前，将胶的薄片放到已固定在光线和物体之间的显微镜台上。
- 将显微镜镜片滑板置于已胶好的薄片上，这样使覆盖物上的两个物镜都完全与薄片交迭。图内部即是任意视区（或参照）。
- 放大100倍后观察样品。
- 用显微镜比较每个参照系，定位最大的碳黑团或碳黑包含物。
- 通过目视比较显微镜下包含碳黑团的可视区域，并参照碳黑 附D35分散参照图。
- 记录与此可区区域最近的类型。
- 重复上述程序直到10个类似读数都被记录。从每个薄片上最多取3个参照数，而薄片数不少于5个。
- 记录每个可视区域的分类。

氧化诱导期

- 通过ASTM D3895中对应的程序，测定氧化诱导期。
- 压膜样品成为薄片样本（厚度250 15 微米）。
- 用穿孔刀从薄金属板上打孔并穴出一块圆板，记录样品的重量。
- 将样品板放入适当型号的面板中。
- 准备一块空的已铝封的面板作为参照。
- 将试验样品及参照面板放入仪器仓。
- 在50ml/分的速率下打开氮气流（绝对压力为140kPa）。
- 调整温度校正软件，设顶龈和锡的熔点分别为156.63和231.97°C。
- 将样品和参照面板装进仪器仓。
- 开始循环加热前用5分钟时间注氮气，以排除残留的氧气。
- 开始根据已设定程序，以20°C/分的速率从常温加热样品到200°C。
- 当温度达到时，中断加热程序，使样品在设定温度下均温5分钟。
- 一旦均温时间已完成，将气体改变为流动率为50 ml/分的氮气。这就是试验程序的零点。
- 继续等温操作直到达到2分钟时间，而此时放热曲线的最晚点已经显现出来。
- 将数据和等温标志一起到y轴上，将时间到x轴上。
- 以分为单位记录结果。

高压OIT

- 根据ASTM D5885中已有程序，测定高压OIT。
- 从实验室样品中取出几个6.3mm（0.25英寸）的圆形样品。
- 用压膜将这些样品压制成统一的薄片，厚度为0.25mm(10密耳)。
- 用6.3mm(0.25英寸)的穿孔刀或穴刀从薄片上切取样品。
- 准备一个质量为51毫克样品。
糙面膜测试

- 将称重后的样品放入已清洁的实验样品瓶里。
- 将样品及参照物放入仪器仓。
- 固定测试室的顶部金属板，并收紧仪器仓系统。
- 关闭压力，释放电子阀及仪器仓的入口阀。
- 调整气缸的压力，使其均衡的提供3.4-Mpa（500-psi）的测试压力。
- 慢慢打开仪器仓的入口阀，用氧气净化仪器仓2分钟。
- 2分钟后，关闭出口阀，使仓内达到全压，接着关掉入口阀以及气缸的氧气供应。
- 开始已定的试验样品加热程序，并以20℃/分钟的速率从常温加热到150℃。
- 在温度程序开始时取零点时间。
- 保持温度在150℃恒温直到探测出氧化发热的峰值。
- 同时，整个试验的热量曲线将被记录。
- 当达到恒温条件5分钟后记录样品温度。
- 当氧化发热的峰值超过它的最大值后，结束试验。
- 在X轴上用热流标距出此数据，对应的在X轴上出时间。
- 以分钟为单位报告结论。

对衬里材料的视觉检验是为了确保材料无小孔、针孔或其他有害的缺陷。

从每日试验中，将由实验室给出质量证书。
Sinotech 高密度聚乙烯糙面土工膜
高密度聚乙烯(HDPE)粗糙面（双糙面）
性能及性能

Sinotech 华中糙面土工膜由高密度聚乙烯(HDPE)树脂制成，使土工膜产品具有优异的品质和良好的韧性。其制造方法使之具有优秀的抗化学腐蚀能力、无添加剂析出和抗紫外线老化的优点。

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华中高密度聚乙烯糙面土工膜最低值</th>
</tr>
</thead>
<tbody>
<tr>
<td>厚度(最小均值), mm</td>
<td>D5994</td>
<td>每1卷一次</td>
<td>0.71 0.68 0.64 0.25 0.25 0.25</td>
</tr>
<tr>
<td>- 10次测试中8次不小于</td>
<td>0.95 1.35 1.70 0.25 0.25 0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 10次测试中的最低值</td>
<td>1.43 1.80 2.13 2.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>粗糙高度1.1 mm</td>
<td>D7466</td>
<td>每2卷一次</td>
<td>0.25 0.25 0.25 0.25 0.25 0.25</td>
</tr>
<tr>
<td>密度, g/cc</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
<td>0.94 0.94 0.94 0.94 0.94 0.94</td>
</tr>
<tr>
<td>最低抗冲强度性能(两个方向)</td>
<td>D6693, IV型</td>
<td>每2卷一次</td>
<td>8 11 16 21 27 32</td>
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<tr>
<td>- 断裂强度, N/mm</td>
<td>11 15 23 30 38 44</td>
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<td></td>
</tr>
<tr>
<td>- 屈服强度, N/mm</td>
<td>150 150 150 150 150 150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 扭曲延展率, %</td>
<td>G.L. 33 mm</td>
<td>12 12 12 12 12 12</td>
<td></td>
</tr>
<tr>
<td>抗拉强度, N</td>
<td>D1004</td>
<td>每2卷一次</td>
<td>93 125 187 249 311 374</td>
</tr>
<tr>
<td>抗撕强度, N</td>
<td>D4833</td>
<td>每2卷一次</td>
<td>240 320 480 641 801 948</td>
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<tr>
<td>恒定抗拉强度应力开裂,小时</td>
<td>D5397（App.）</td>
<td>90,000 kg</td>
<td>400 400 400 400 400 400</td>
</tr>
<tr>
<td>碳黑含量, %</td>
<td>D1603</td>
<td>每2卷一次</td>
<td>2 - 3 2 - 3 2 - 3 2 - 3 2 - 3 2 - 3</td>
</tr>
<tr>
<td>碳黑分散度</td>
<td>D5596</td>
<td>每2卷一次</td>
<td>注释3 注释3 注释3 注释3 注释3 注释3</td>
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<tr>
<td>参考</td>
<td>ASTM测试法</td>
<td>频率</td>
<td>Sinotech华中高密度聚乙烯糙面土工膜常规值</td>
</tr>
<tr>
<td>厚度, mm</td>
<td>D5994</td>
<td>每1卷一次</td>
<td>0.75 1.00 1.50 2.00 2.50 3.00</td>
</tr>
<tr>
<td>氧化诱导期(11T)</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100 &gt;100 &gt;100 &gt;100 &gt;100 &gt;100</td>
</tr>
<tr>
<td>标准11T, 分钟</td>
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<td></td>
<td>198 152 128 98 76 64</td>
</tr>
<tr>
<td>卷长, 米</td>
<td>7 7 7 7 7 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>卷直径, 米</td>
<td>1,386 1,064 896 686 532 448</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

注释：
1. 10个测试值, 至少8个达到≥0.18 mm, 其余2个≥0.13 mm。
2. SP-NCTL测试不适用于糙面土工膜，检测应该在糙面土工膜的光滑边缘部分进行，或使用于糙面土工膜相同的光滑面片进行。
3. 碳黑含量度(实测型图样)，取10个不同数值：
   - 4个属于类型1或2，1个属于3类。

这些数据均为最低值(特别说明的除外)。上述规格达到或已超过了“土工合成材料协会(美国GRI)”的W-13标准，并作为国际性的技术指南，以协助工程技术人员。在这里印出的数值不作为技术设计的依据或保证，华中公司对于技术指标的品质将明确在合同中。华中公司有可能改进这些规格但不再另行通知。
## Sinotech线性低密度聚乙烯糙面土工膜

### 线性低密度聚乙烯(LLDPE)粗糙面（双糙面）

### 测试频率及性能

Sinotech华忠的LLT土工膜是以最好的线性低密度聚乙烯(LLDPE)为主要原料制造，因此成为具有极高品质的超柔性土工膜；华忠LLT土工膜有单面或双面共挤粗糙表面；所依据的生配方使其具备抗化学腐蚀、无添加剂析出和抗紫外线老化的优良性能。

### 性能

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华忠线性低密度聚乙烯土工膜最低值</th>
</tr>
</thead>
<tbody>
<tr>
<td>厚度（最小平均值），mm</td>
<td>D5994</td>
<td>每1卷一次</td>
<td>0.71</td>
</tr>
<tr>
<td>10次测试中8次不小于</td>
<td>0.68</td>
<td>0.90</td>
<td>1.35</td>
</tr>
<tr>
<td>10次测试中的最低值</td>
<td>0.64</td>
<td>0.85</td>
<td>1.28</td>
</tr>
<tr>
<td>粗糙高度，mm</td>
<td>D7466</td>
<td>每2卷一次</td>
<td>0.25</td>
</tr>
<tr>
<td>密度（最大），g/ml</td>
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<td>90,000 kg</td>
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<tr>
<td>最低拉伸性能（两个方向）</td>
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<td>- 断裂强度，N/mm</td>
<td>G.L. 50mm</td>
<td>250</td>
<td>250</td>
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<tr>
<td>- 断裂伸长率，%</td>
<td>2%模数（最大），N/mm</td>
<td>370</td>
<td>420</td>
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<tr>
<td>抗拉强度，N</td>
<td>D1004</td>
<td>每2卷一次</td>
<td>70</td>
</tr>
<tr>
<td>抗拉弯度，N</td>
<td>D4833</td>
<td>每2卷一次</td>
<td>150</td>
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<tr>
<td>轴对称拉伸断裂裂口，%</td>
<td>D5617</td>
<td>30</td>
<td>30</td>
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<tr>
<td>碳黑含量，%</td>
<td>D1603</td>
<td>每2卷一次</td>
<td>2 – 3</td>
</tr>
<tr>
<td>碳黑分散度</td>
<td>D5596</td>
<td>每2卷一次</td>
<td>注释2</td>
</tr>
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</table>

### 参考

<table>
<thead>
<tr>
<th>性能</th>
<th>ASTM测试法</th>
<th>频率</th>
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</tr>
</thead>
<tbody>
<tr>
<td>厚度，mm</td>
<td>D5994</td>
<td>每1卷一次</td>
<td>0.75</td>
</tr>
<tr>
<td>氧化诱导期（OIT）</td>
<td>D3895</td>
<td>90,000 kg</td>
<td>&gt;100</td>
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<tr>
<td>标准OIT，分钟</td>
<td>198</td>
<td>152</td>
<td>128</td>
</tr>
<tr>
<td>卷长，米</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>卷宽，米</td>
<td>1,386</td>
<td>1,064</td>
<td>896</td>
</tr>
</tbody>
</table>

### 注释

1. 10个测试值，至少8个达到≥0.18mm，其余2个≥0.13mm。
2. 碳黑分散度（仅球型团周围），取10个不同数值：
   - 至少9个属于类型1或2，1个属于3类。

这些数据均为线性低密度聚乙烯(LLDPE)土工膜的常规值。上述规格达到或超过国际标准，为国际质量的土工膜，以协助工程师设计人员。华忠公司对于技术指标的准确性将明确在合同中，华忠公司有权利改进这些规格但不再另行通知。
Sinotech高密度聚乙烯糙面土工膜
高密度聚乙烯(HDPE)粗糙面（单糙面）
测试频率及性能

Sinotech华忠HDM土工膜由高密度聚乙烯[HDPE]树脂制成，使土工膜产品具有优异的品质和良好的韧性。其制造配方使之具有优秀的抗化学腐蚀能力、无添加剂析出和抗紫外线老化的优点。

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<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华忠HDM土工膜最低值</th>
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<td>Sinotech 品代码</td>
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<td>厚度（最小平均值）</td>
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<tr>
<td>- 10次测试中8次不小于</td>
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<tr>
<td>密度，g/cc</td>
<td>D1505/D792</td>
<td>90,000 kg</td>
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<tr>
<td>最低拉伸性能（两个方向）</td>
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<td>- 断裂强度 N/mm</td>
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<td>- 屈服强度 N/mm</td>
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<td>- 断裂延伸率，%</td>
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<td>- 屈服延伸率，%</td>
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<td>恒定拉伸后力学特性开裂,小时</td>
<td>D5397 (App.)</td>
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<td>碳黑含量，%</td>
<td>D1603</td>
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<tr>
<td>碳黑分散度</td>
<td>D5596</td>
<td>每2卷一次</td>
<td>注释3</td>
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参考
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<tr>
<th>ASTM测试法</th>
<th>频率</th>
<th>Sinotech华忠HDM土工膜常规值</th>
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<td>厚度，mm</td>
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<td>氧化诱导期（OIT）</td>
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<td>卷面积，平方米</td>
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注释:
1. 10个测试值，至少8个达到≥0.18mm。其余2个≥0.13mm。
2. SP-NCTL测试适用于糙面土工膜。检测应该在粗糙面土工膜的光滑边缘部分进行，或使用于粗糙面配方相同的光滑面片进行。
3. 碳黑分散度（仅硅型料圈），取10个不同数值，取至少9个属于类型1或2，1个属于3类。

这些数据均为最低值（特别说明的除外）。上述规格达到或已超过了“土工合成材料协会(美国GRI)”的WM-13标准，并作为国际性的技术指南，以协助工程技术人员。在这里印写的数表不单独作为其担保或保证。华忠公司对于技术指标的负责仅限在合同中。华忠公司有可能改进这些规格但不再另行通知。
粗糙度测试

密度仪
用于测定密度的试验仪器（ASTM D1505或ASTM D792）
<table>
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<th>面膜测试</th>
<th>光面膜测试</th>
<th>原料实验</th>
<th>须知</th>
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