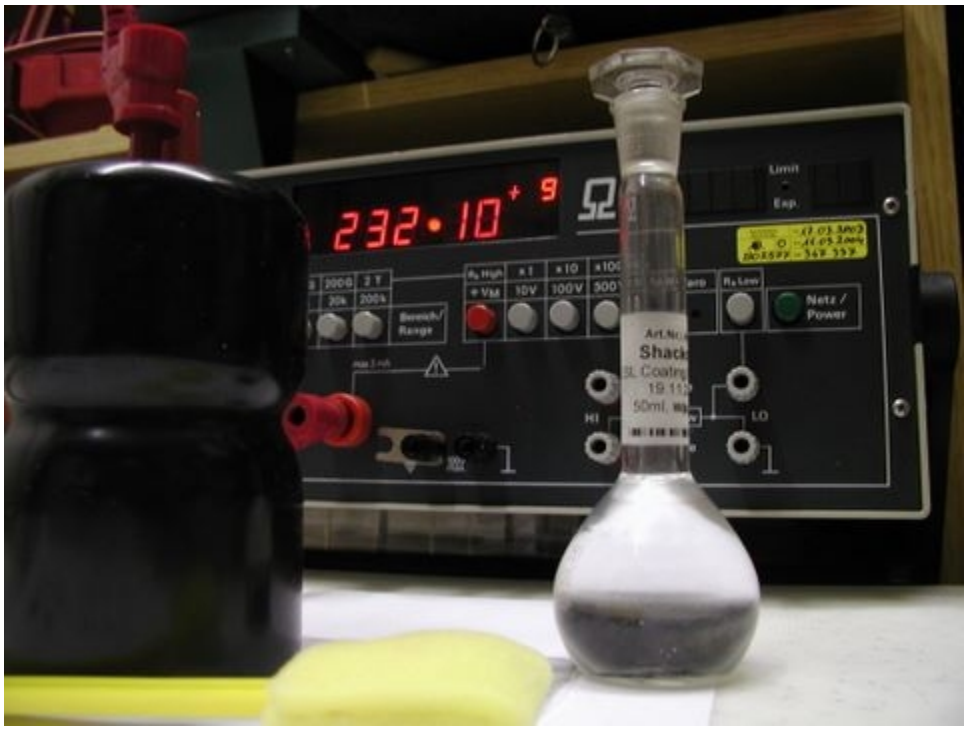
Application Guidelines

for

SHACKMAN ESL Conductive Coating Liquid

VLC Coating Type PMMA 2.5E11



You purchased a modern high technology SHACKMAN product.

Congratulations and thank you very much.

Please, pay attention to the correct application of this product.

So you can be sure to profit from the advantageous properties of this product.

We wish you a lot of success for your works on electrostatic loudspeakers.

Electrostatic loudspeakers – they have it.

Enjoy the difference.

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S.A.E., Shackman Acoustical Engineering, Reiner E. Römer,

http://www.shackman.de

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Shipping Contents

Please control the contents of the delivery. You should have received:

1. Coating liquid, in a laboratory glass
2. Contact liquid, black , in a tiny test-tube
3. Contact foil, gold
4. A pair of latex gloves
5. Cotton wool ball/tips
6. double sided conductive sticky pads

Technical notes

The ICP Substrate in Shackman VLC coating liquid

Polymers which conduct the electric current without addition of conductive, inorganic substances, are called " intrinsic conductive polymers " (ICP). The special properties of the ICP are lying in its poly-anionic structure and its specific morphology.

If these small polymer particles of 0.05 to 1.0 micrometre in size are formed as a dispersion in water or organic solvent and if the polymer is above its glass transition temperature and is rubbery in nature, then a clear polymer film may form after the dispersion is applied to a substrate.

The polymer particles suspended in the water flow together, or coalesce, to form a film because of surface-mediated forces. If the polymer is below its *transition temperature* and is therefore in a rigid, glassy state, a small amount of coalescent - a solvent that will plasticize the polymer and lower its effective transition temperature- is added to the system to assist film formation. This coalescent later evaporates, leaving the solid polymer film.
Therefore, Shackman PMMA 2.5 is not really soluble, like all intrinsic conducting polymers, and does not have a melting point or other softening or tenderizing properties. or this reason PMMA can not be handled like an ordinary thermoplastic polymer.

A processing into a coating liquid is achieved by PA which is dispersed in an adequate solvents. That gives a kind of nano like attribute to the conductive agent in the solution.

That is why, under atmospheric conditions, PMMA 2.5 is long term stable and widely inert to environmental factors. PMMA 2.5 is absolutely safe in the use and absolutely harmless for the environment.

Advantages

Concerning electrostatic loudspeakers, these facts are of great importance, because not only the conductivity itself counts, but also its long term stability in daily acoustical use in domestic environments.

Until the 1980s, SHACKMAN products used to use very light double-side insulated paper-like material as “composite diaphragm”. That was a kind of natural material and therefore never lost its natural high ohmic conductivity. That is one of the reasons, besides all other innovative items, why these transducers were so successful in those decades. They have been used as tweeters in Quad ESL57 upgrades and they still work fine, because the diaphragms cannot loose their conductivity

We use PMMA on ICP basis since 1991 without any problems. The conductivity is lasting, constant and nearly unaffected by temperature and air humidity. Today we measure the same conductivity as it has been measured 15 years ago. That means that the

electrostatic-acoustical properties did not change at all over that period.

That stable performance in resistivity is not only a long term must for the coating, but also a daily task. Especially in hybrid systems, where the ESL only takes the upper frequencies, a change in sensivity would immediately change the tonal balance to the bass driver.

In full range electrostatic loudspeakers, that is not that much a problem, as the ESL transducers all frequencies.

➢ **IMPORTANT NOTE:**

If you are using modern SHACKMAN PP-PHD foil, keep in mind, that the

DOWN / INNER SIDE of the roll is pre-treated

You can make this side either

a.) the coating/metallization side

or

b.) the gluing side.

We recommend to use it as the gluing side, as the Shackman-reromanus liquid sticks very well to all kind of surfaces.

The Coating Procedure

General informations

➢ IMPORTANT GENERAL NOTE ➢ **Read these instructions carefully**

➢ Please always pay absolute attention to all possible or available cleanliness and tidiness. During the work and production phase, you should never touch the foil without gloves. It will influence the physical and chemical contact of the coating to the foil. Your working area should be in a room, which is as clean and dust free as possible (bath/kitchen).

➢ You should clean the foil to be coated with isopropanol, before applying any coating liquid.

➢ Please pay attention - **always** - to the unpleasant effect of high voltage.

➢ We suggest to make one or two tries on small sheets of foil before starting on the final diaphragm in order to learn about the behaviour of the drying liquid..

Preparations

➢ **A**. Which tools do you need.

Brush and/or cotton sticks, latex gloves, line cloth and/or kitchen paper or cotton pads. An electrometer(e.g. Keithley) if available, but not urgently necessary. Normal meggars (isolationmeters) do a good job as well. But keep in mind that you will always measure nothing but relative results.

➢ **B.** You should place the foil on very flat planar surface like a window pane or a mirror. No question that this surface should be extremely clean and absolutely dust free.

Picture 1: Necessary tools

Let us go.

Step 1. Prepare your tools as seen in picture 1, put on the gloves, shake the bottle contents well and thoroughly, so that all particles are well distributed in the bottle.. Apply the liquid with a small hair/bristle brush or a cotton wool tip, - depending on the size of your diaphragm area - to the foil by carefully distributing small drops all over the area, beginning in the centre and omitting the corners. If you are coating a curved panel like e.g. the Shackmans, you have to begin right in the middle of the diaphragm in order to avoid the liquid running away.

You really cannot apply too little, only too much. If necessary, shake the liquid over and over again. Do not forget do be very carefully concerning the contact with the liquid. It only has to get in contact with the diaphragm and the HV contact area.

Step 2. Immediately distribute each drop of the quickly drying liquid as regular as possible with an adequate tool all over the intended diaphragm area., omitting the extreme corners and borders. Begin in the middle and follow diagonal and contra-diagonal directions, like a house painter usually does.

Step 3. Allow the coating to dry completely until the solvent has evaporated. This will happen pretty quickly. The foil will surely look a kind of speckled due to the more or less accidental adhesive distribution of the solvent. But that does not matter at all.

Step 4. Then with a clean linen cloth culinary/kitchen paper) distribute the rest of the substance with controlled pressure well and steadily. This is like polishing a mirror. Only a kind of thin veil will left. The thinner the film becomes, the higher the resulting surface resistance will be.

➢ **NOTE**: Measurements cannot be done by a normal standard multimeter. Using an electrometer, you will now measure a resistance of about 10E9 Ohms. A "Maggar" (Isolation Meter) can help but will only give relative results

Step 5. After waiting a couple of hours, you can adjust the conductivity by further rubbing and polishing the coating film. NOTE: But be careful. Very easily you may crinkle or wrinkle the foil. That is not desired at all. This could later cause the occurrence of corona, affecting the over all performance of an electrostatic speaker.

Step 6. Do not use the coated foil - by no means - immediately after production. Only after at least a couple of days of remaining drying time, the foil can be safely charged as an ESL diaphragm with polarization voltage and be used as an electrostatic loudspeaker. Store the foil at at sure and dust free place and/or protect it with an appropriate cover.

Step 7. Only after that time, just before you tense or stretch the diaphragm to your stators, once again cautiously polish the surface. You may think, that all the conducting liquid has been polished away. But no way. You can be sure, that there will be enough and appropriate conductivity. After that final treatment, the conductivity should be round about 10E11 S/cm and will be preserved permanently and for ever.

Brief Summery of the coating procedure:

Step 1.	Preparation
Step 2.	Apply the liquid
Step 3.	Distributing the coating liquid
Step 4.	Waiting 2-3 hours
Step 4	Polishing
Step 5.	Waiting some days
Step 6	Polishing again

➢ **NOTE:** A later moderate heat treatment of the foil - in order to adjust the mechanical tension or for unwrinkling purposes - is harmless to the effectiveness of PMMA 2.5.

The high voltage contact area

The best coating is not worth anything, not having an efficient contact to the applied high voltage. Therefore one should take very much care in realizing a reliable contact area. For reaching that important goal, you may use the special Shackman-reromanus contacting material. It ensures a corrosion free contact to the coated film.

Mark the intended contact area with the black conductive liquid. using an appropriate tool. You may also use an old dried out felt tipped pen. Glue the high resistance side of the contact foil very carefully to that diaphragm area by either using the conductive double sided sticky pads or any other conductive glue.

For making that contact area really perfect, you should cover the whole contact area with a sheet of insulating film. This will give you a sure and lasting contact for the polarisation high voltage supply.

Especially with the very high resistivity version of the coating liquid you are proposed to draw a “contact line” around the diaphragm, beginning and ending at the actual contact area. That is for better and faster charging of the diaphragm.

Outlook

We use PMMA on ICP basis since 1991 without any problems. The conductivity is lasting, constant and nearly unaffected by temperature and air humidity. Today we measure the same conductivity as it has been measured 15 years ago. That means that the electrostatic-acoustical properties did not change at all over that period.

But in practice, one of the most important and much too often neglected things is the actual electro-physical contact of the high voltage to the conductive coating by the metallic contact. Especially under long term stability aspects one cannot be rigorous enough in choosing the right material.

That is why we use gold plated contacts and a special conductive adhesive, which glues the copper strip to the coated film area. In real electrostatic life this is the very essential item, which is decisive concerning the over-all longevity of an electrostatic loudspeaker system.

However, it is required to follow these application guidelines very precisely. In particular, please pay attention to absolute cleanness of the workplace.
A small metal fragment can have disastrous consequences.
Also touching of plastic foil with bare hands will result in poor quality.
We wish you a lot of success with your tests and developments. And: Have fine Music!

For further inquiries, please address to: service@shackman.reromanus.net

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