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Trip Report

Destination: Sylvania Electric Products, Seneca Falls, New York
Date of Contact: December 21, 1955
Persons Contacted: Lyle Evans and Ted Rychlewski
Report By: P.F.E. Marapodi and W. Rublack

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Purpose of Trip: To observe and discuss Sylvania's dust settling technique to screen color t.v. tubes.

A. Screening the facepanel - chronological order of processing stages:

1. Panel inspection.
2. Wash panel and dry.
3. Apply a solution of unsensitized PVA and deionized water to the panel to pre-condition the glass surface and dry; concentration of PVA is the same as the unsensitized stock solutions.
4. When ready for production, wash pre-coat PVA film off and dry.
5. Place panel in a ventilated hood and spray on the photo-resist solution. Use a DeVilbiss MBC spray gun, cap #30, 30 psi with gun nozzle eight inches away from panel surface to be filmed. Spray back and forth across the diagonals of the panel and finish with a horizontal pass in one direction only, right to left or vice versa. Panel must be wetted completely, with no dry spots on panel surface.
6. Place panel in a horizontal plane face down and place a cone on said panel.
7. Phosphor powder is blown into the cone with a special gun, at timed cycles. The phosphor particle stream is ejected horizontally from the gun and enough turbulence results to get uniform distribution of the phosphor on the wet photo-resist solution. About twenty-two puffs from the gun are necessary to deposit enough phosphor per color.
8. Depth of phosphor layer can be measured relative to transmitted light as detected by a photo-cell using a clean panel treated with wet PVA as a standard. The light source, a 25-watt yellow lamp, is placed at the aperture of the cone after the last phosphor puff and naturally the photo-cell is placed on the outer surface of the panel.
9. Air settle the phosphor for one minute after puffing.
10. Remove cone and dry screen with an office fan (or other similar type) which is placed about fifteen inches from the treated panel surface. Room temperature should be 73 - 75°F and relative humidity 47±3%.

11. Expose for an average of two minutes per color, the photons of light impinging upon the phosphors. The exposure source in the light house consists, from bottom to top, of a concaved reflector facing upward, a BH-6 lamp, a quartz collector and a mask through which only the tip of the quartz collector protrudes to give a point source of light.
12. Develop with de-ionized water using a soft spray from a shower nozzle.
13. Dry with fan as in step (10) above.
14. Repeat steps 5 through 13 for the other two colors.

B. Specific information on various processing stages described in A above.

1. Step A-5 Photo-resist formulae:

a. Stock solution A (grade 52-22 PVA)
   1. 22.5 gms PVA - 52-22
   2. 600 mls de-ionized water

b. Stock solution B (grade 51-05 PVA)
   1. 22.5 gms PVA - 51-05
   2. 600 mls de-ionized water

c. Stock dichromate solution C
   1. 5.5 gms ammonium dichromate
   2. 25 mls de-ionized water

d. Photo-resist blend for blue and green phosphors
   1. 250 mls of stock solution A
   2. 250 mls of stock solution B
   3. 500 mls of anhydrous solox
   4. 25 mls stock solution C

e. Photo-resist solution for the red phosphors
   1. 500 mls stock solution A
   2. 500,mls anhydrous solox
   3. 25 mls stock solution C

Note: Grade 51-05 PVA is low in viscosity and it is claimed by Sylvania personnel to enable the first phosphor dot or stripe to be printed with relative ease. It is immaterial which color phosphors are screened first and second - photo-resist solution B-1-d should be used for each, while photo-resist solution B-1-e should be used for the third color.

2. Step A-7 Phosphors

a. Phosphors must be dried by the vendor or laboratory personnel for four hours at 175 - 200°C before bottling to reduce clumping possibilities when used for dusting.

b. Prior to inserting the phosphor gun in the cone it must be cleared with several puffs to see that a good stream of phosphor powder is ejected. In addition, the cone itself must be cleaned, inside and out, with a blast from a high pressure air gun.

3. Step A-10 Drying

a. Experiments are being run to determine if infra-red baking can replace the fan to dry the panel after dusting. These lamps can be placed in banks at appropriate positions in the line.

C. A comparison of G.E.'s and Sylvania's method of screening with reference to the time function of one stripe.

Process	G.E. (min)	Sylvania (min)
1. Pre-coat photo-resist spray	--	1
2. Dry	--	5
3. Wash	--	3
4. Dry	--	10
5. Photo-resist application	4	1
6. Dry	10	5
7. Expose	2	2
8. Phosphor application	4	3
9. Dry	8	--
10. Develop	3	3
11. Dry	10	10
Total time - minutes	41	24 +(1/3C1 to C4)=30

Notes: (a) Steps C5-C11 represent the chronological order of printing for the G.E. process only, and the time function for the similar Sylvania process noted.

(b) It may be possible to eliminate steps C1-C4 in the Sylvania process to reduce their overall time to 24 minutes.

D. On statements made by Sylvania's personnel pertaining to their process and observations of their technique.

1. During their last visit to General Electric, Sylvania claimed to have had an overhead exposure unit in their assembly line.

a. No such machine was in view. The panels, RCA circular, were removed from the line and exposed on an RCA or RCA modified exposure machine.

2. The process is continuous, Sylvania implies.

   a. It is dis-continuous. The entire line stops to spray the photoresist on the panel and to dust the phosphor on the screen. However, advantage is taken of these stops for the drying, exposure and developing processes to be performed.

3. There is no contamination with this method.

   a. Panels inspected on the line with a microscope after screening the first dot showed a considerable amount of phosphor particles around each dot. This will contaminate the second and third dots printed. Furthermore, a considerable number of voids were noticed in the dots screened.

4. The brightness of the phosphors are increased by this method.

   a. Sylvania screened two 21" tubes, one with the Apple and the other with their process. Both panels were identical in geometry, and were screened on the Apple exposure unit. Under identical conditions of test the Sylvania processed tube had a light output of 46 foot-lamberts while the Apple tube had 27 foot-lamberts for a ratio of 1.7-1. These values are relative and not absolute since the tubes had neither grilles nor aperture masks. Furthermore, the Apple type tube had a definite guard band while the tube processed via Sylvania's technique had none. This will further reduce the above ratio of 1.7-1.

   While the degree of line loading of phosphor is important from the viewpoint that it is preferable to convert, theoretically, 100% of the energy of the electron beam to photons of light by virtue of energizing the phosphor particles, the method by which this is done is relatively unimportant except for the over-all economical aspect involved. It must be emphasized rather strongly that Sylvania noticed a 1.8-1 increase in brightness when they double screened the Apple tube. Again, this means nothing. What is significant is how well did they do on getting enough phosphor in the line on their first screening step with the Apple process. We had double-screened our Apple tubes when we heard of this and only found a 1.2-1 increase in brightness, indicating that we have done a better job of loading the line with phosphor on the first attempt. We specifically tailor the exposure time for the particular phosphor involved. The result of phosphor adhesion to polymerized PVA is a surface chemistry problem, and since the molecular structures of the three phosphors are different in addition to their particle size, we are bound to get different reactions with each type.

   In the tube viewed with the Sylvania dusting technique employed only a nine inch by six inch rectangular area at the geometric center of the tube face showed good line quality. Beyond this area, towards both edges of the tube along the long axis, the line structure was noticeably bad. All lines looked as though they were fourteen mils in width except the red line which appeared to be twenty to twenty-eight mils in width and covering the green line entirely. This presents a problem in improving the technique of applying the photo-resist spray, phosphor development, drying conditions and exposure times. Sylvania personnel admitted that they were having difficulties with the above. Applying the photo-resist solution is especially critical since, by our theory, Sylvania apparently deposits too much photo-resist at the edges of the tube such that the photo-resist film thickness from center to edge varies considerably. Since they deposit phosphor powder on a wet surface a capillary creep of PVA results, wetting the phosphor particles to a greater height at the edges than at the center. On exposure, the ultra-violet beam is scattered more at the edges than the center, thus giving a very wide line and overlapping.

5. Sylvania claims their method uses less phosphor.

   a. This is true. Disregarding that which may be reclaimed, Sylvania uses (approximately) 15 grams of phosphor to screen a complete tube. We need approximately 54 grams to accomplish the same result. Furthermore, their problem of phosphor recovery is relatively simple since they have no other chemicals to separate from the phosphor at reclaimation.

E. Other observations, etc.

1. Sylvania uses the standard RCA gun for their color tube.

2. Phosphor particle size:

a.	Green	5 - 40 micron range
b.	Red	5 micron average
c.	Blue	10 micron average

3. Phosphor gun equipment

   a. Ted Rychlewski will send complete details on equipment parts, detailed sketches for assembly, and circuit diagrams.

   b. However, we can screen experimentally in this fashion without this elaborate set-up.

4. Dusting technique

   a. Sylvania may claim this is their idea, however, on a recent trip to Philco, Mike Sadowsky claimed that he had dusted phosphor on PVA.

   b. Above statement included to inform management that Sylvania may not have as strong a bargining position as they would like us to believe should they go POFP with us and assuming we use their screening method.

F. Conclusions

1. From the possibility of reducing the over-all time cycle in screening a color tube and phosphor cost reduction, Sylvania's dusting technique appears to hold promise.

2. Sylvania is having difficulty in obtaining optimum screening parameters, the process not being fully perfected at this stage.

3. We recommend that we continue screening the bulk of our tubes with our present method.

4. We further recommend that we experiment with a few tubes utilizing the Sylvania technique and evaluate results thoroughly. If results are comparable or better than Sylvania's, it may be worthwhile to delegate more time to establish the conditions which will permit is to obtain optimum parameters.

5. We recommend that not too much activity or emphasis be placed upon Sylvania's technique until such time when we can evaluate it thoroughly with our own and Philco's new, yet undisclosed, approach. When this method has been perfected, Mike Sadowsky has assured us that we would receive all necessary information. What was observed at Philco was far superior to either the General Electric or Sylvania techniques of screening.

6. We further recommend that the "burden of proof" of this method be placed with Sylvania. We know, essentially, enough about screening problems to be able to switch from one method to another should a superior process be devised that obsoletes all present methods.

7. We shall continue to try to establish conditions to improve our own screening results.

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