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RESISTANCE TEST OF DEPOSITED ALUMINIUM LAYER ON PARABOLIC PARTS OF VEHICLE HEADLIGHT

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Abstract:
This paper documents a basic quality measurement in an automotive light industry. The experiment is based on a verification of reflective aluminium layer resistance against 100% humidity and higher temperature. This simulates the lifetime of a headlight on vehicle. The goal of this test is to prove that the reflective aluminium layer is able to resist to this environment without any changes in its structure. If any change occurs, the modification of production process will be needed.

Key words: *automotive industry, headlight, metallization, humidity, higher temperature, resistance*

INTRODUCTION

Requirements of the current market for products in the automotive industry are on quite high level. Production of headlight is part of the transformation process, i.e. specific conversion of production factors (inputs) onto products (outputs). This transformation is a manufacturing process which comprises a number of work and automatic processes and is limited by a time interval, in which the initial inputs are converted into outputs.

Manufacturing process can be characterised as a creative process, whose function is creation of use values.

Headlight manufacturing process consists of following steps:
- injection of plastics (injectors Engel 50 – 650t),
- surface treatment of the plastic parts – aluminium metallization,
- automatized line for hardening of plastics with varnish + UV radiation,
- assembly lines (special purpose equipment - production lines controlled by Siemens Simatic). (ZKW 2013)

Deposition of metal layers on the headlight parts

Deposition of the metal layers is performed by a special, so-called. sputter devices. Parts are fixed to the carriers, which are placed in a closed chamber. After pumping out the chamber to the rough vacuum (from 1.10^{-1} mbar to 1.10^{-2} mbar) cleaning discharges underway on parts, which are used to prepare the surface for evaporation of aluminium.

Subsequently, the chamber is pumped out into high vacuum (from 1.10^{-4} mbar to 1.10^{-5} mbar) when aluminium is evaporated by a tungsten coil and then it condense on surface of the parts to forma n aluminium layer. For aluminium deposition is used an aluminium wire with purity from 99.95% to 99.99%.

In the next process of the cycle is protective film of HMDSO (hexamethyldisiloxane – Silicone) deposited on an aluminium layer to protect it from the atmospherical humidity. (LPH, 2010). The aim of this paper is to test the quality and resistance of these layers in simulated working conditions against 100% humidity and higher temperature. Load will simulate the condensation of steam in the headlight and its impact on the aluminium layer.

MATERIALS AND METHODS

Tested samples

As a tested samples were used parts of headlight from production testing sequence. Assembled headlight and tested sample are show on Figure 1. Testing is focused on resistance of parabolic reflection surface of the headlight where due to the condensation of humidity the aluminium layer can detach from the base material. Three samples are needed to be tested, each from different part of coating chamber. One from the upper part, second from the middle part and last one from the bottom part of the coating chamber. The reason is thorough verification of aluminium dispersion in the whole volume of the coating chamber.

Fig. 1 Assembled headlight (left) and tested sample (right)

Testing device and parameters of the test

The test is based on the standard EN ISO 6270-2:2005 Paints and varnishes – Determination of resistance to humidity – Part 2: Procedure for exposing test specimens in condensation-water atmospheres.

Whole test is performed in environment with temperature at 40°C. Relative humidity at the level of 100% is required. The duration of the test is 120 hours. Samples are monitored for any change or damage of aluminium layer. First control is done after 48 hours and then the samples are controlled after 120 hours. After each control the condition of the part is evaluated and documented by a camera. Testing device is a constant climate chamber, where the parameters of the humidity and temperature can be set (Fig. 2).

Fig. 2 Testing device – constant climate chamber

RESULTS AND DISCUSSION

On the Figure 3 are tested samples prepared for test and placed in a testing device. It is required to set the samples into the position and orientation close as much as possible to the position on the vehicle.

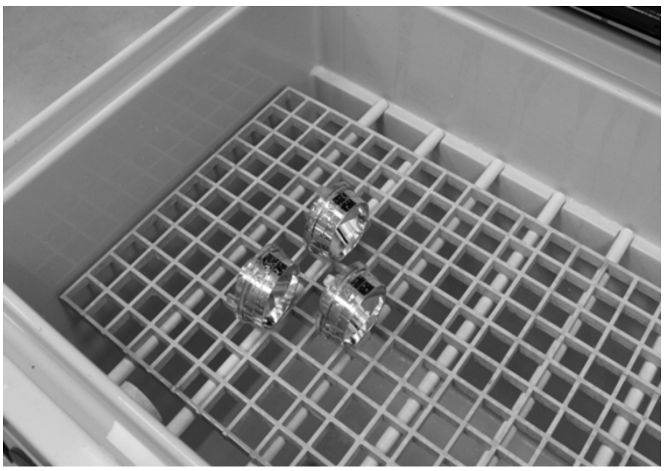

Fig. 3 Placement of the samples in testing chamber

Control after 48 hours

After 48 hours of testing the process was interrupted. Samples were taken out of the testing device and were dried by compressed air. Then the technician assessed the condition of reflective aluminium layer. As is seen from Fig. 4, no damage of aluminium layer occurred. The samples were placed again into the chamber and test was relaunched.

Fig. 4 Tested samples after 48 hours

Final control after 120 hours

After completing the test, the samples are taken out from testing device and cleaned with compressed air. By a visual control the technician is looking for any defects or damage on reflective aluminium layer. The result is that after the whole duration of test, the sample from the bottom part of coating device is not in good condition. The damage of aluminium layer has occurred (Fig. 5). This damage is unacceptable and represents the possible inappropriateness of the production process. All remaining samples were in good condition.

Fig. 5 Visible damage of reflective aluminium layer

This kind of reflective layer damage in the form of its separation from the base material point out that the layer does not have appropriate thickness, which can guarantee its resistance. After consultation with technologists, we have decided to modify the manufacturing process by multiplying the time of parts deposition in coating chamber. This was made due to, first increase the thickness of the applied layer, since the longer time means more deposited material, but also because of the thorough dispersion of vaporized aluminium in the coating chamber and thereby the thorough deposition on component.

After the modification of production process three samples were taken from the first batch for the testing. The test was done with the same parameters and on the same device like the first time. In this paper we just present results after 120 hours, because the test was positive.

Result of the test after 120 hours – modified production process

By modifying the production process the overall quality of the deposited aluminium layer has raised, thanks to that it was able to resist testing conditions. As seen from Fig. 6, all samples are without visible damage of reflective aluminium layer.

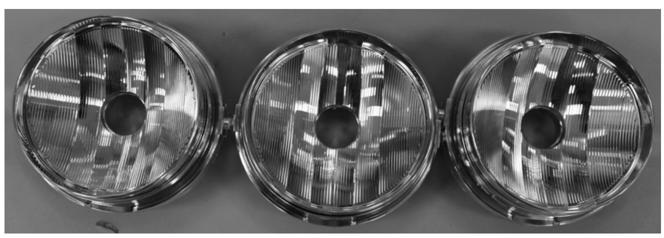

Fig. 6 After 120 hours no visible damage has occurred on tested samples

CONCLUSION

Headlight production is very sophisticated and specific process, which must by constantly monitored and controlled to reach demanding level of quality. By a regular control of production process and by testing of the specimens we can prevent mistakes and low quality products.

The test described in this paper represents basic type of quality tests of the headlight, and as it was proven, it has revealed deficiency in manufacturing process. The deficiency was represented by an inappropriate resistance of reflective aluminium layer against environment with higher temperature and 100% humidity. By modifying the manufacturing process with extending the period of deposition of the aluminium layer we have reached the required quality of the reflective layer. By confirming it with a test the manufacturing process was launched into mass production. This does not mean that it is not necessary to do further testing of these products. After setting the mass production of these products it is necessary to do these tests in regular intervals to ensure the quality of supplied products.

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