Application of the interference method of studying the surface for quality control and internal structure of the luminescent crystals and microelectronic products.

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At the present time in connection with the development of methods of nondestructive testing are becoming increasingly relevant research characteristics of fluorescent converters. [1]

For the control of microelectronic products and objects whose surface has topographical changes in the structure down to nanometers, using X-ray and digital radiography systems, the extremely high requirements for the quality of fluorescent light converters. This is necessary in order to eliminate the influence of inhomogeneities of luminescent crystals on the quality of X-ray image. Ordinary optical microscopes can not effectively register the quality of the crystal surface, and therefore becomes relevant application interferentsialnogo method for investigating the surface.

The development of fluorescent converters one of the main objectives is to increase the contrast of the image and increase the sensitivity of the flaw. For the most part, these characteristics are determined by the uniformity of the luminescent layer and the presence of structural defects.

For luminescent converters based on single-crystal CsI (Tl) sensitivity and contrast of the image are determined by the quality of surface polishing. At the same time to ensure the sensitivity of 0,5-1%, the structural defects on the surface of the screen should not exceed 0,5-1 microns.

In this connection there is actual problem of technological quality surfaces fluorescent converters in their manufacturing and research the causes of structural defects.

This problem can be solved by using an optical interference microscope NewView 7300.

Optical interference microscope NewView 7300 uses to scan the surface of white light, part of which focused on solid-state sensor for the construction of a grayscale image, the other part is directed to the interference of light to measure the micro-structure and construction of a surface in three-dimensional space without contact with the sample.

This device can examine almost any sample with the reflection coefficient of 1 to 100% and record the features of relief from the roughness of nanometer-scale steps to the millimeter in height. Permission is normal to the sample for the optical interferometer is tenths of a nanometer (0.1 nm vertical). Out the received graphic image with high resolution, accurately analyze the characteristics of structural surfaces.

For example a very effective is the control of the working surface of microelectronic products. Figure 1 shows the surface structure of chips with aluminum metallization steps is subject to certain requirements for the height of the application.

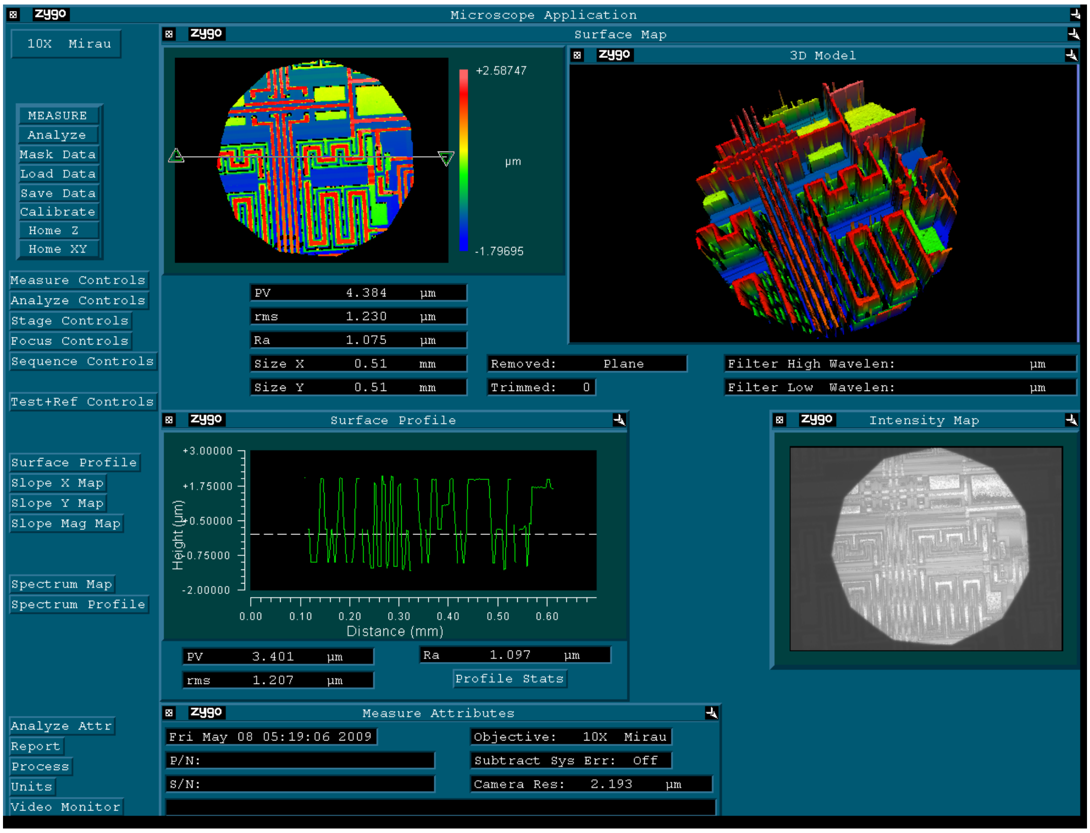

Figure 1. Chip with aluminum metallization steps.

The three-dimensional measurements obtained by vertical measurements using interferential and horizontal dimensions of the surface calculated from the size of pixels of solid-state sensor. With the latest software systems to improve the accuracy and speed control. The measurement results are presented in the form of images of surfaces, graphs and numerical values of surface parameters such as Ra, Rz, etc.

Another advantage of this device is the control surfaces of large area. Depending on the size of the lens exciting area of the object varies from 7.04 × 5.28 to 0.07 × 0.05 mm (available lenses 1, 2, 2.5, 5, 10, 20, 50,100 fold increase), but thanks to matching image software product and is fully motorized table movement the sample study area increased to 140 × 100 mm. Existing X-ray introscopes based on the use of digital radiography systems with fluorescent X-ray converters that provide flaw sensitivity of 1-2% in the energy range 50-300 keV. Approximately the same sensitivity for the method of film radiography with fluorescent amplifying screens. Given that the flaw sensitivity is proportional to the contrast sensitivity and taking into account that the SRDC and have optical contrast sensitivity of 0,1-0,2% logical to conclude that the main element limiting the sensitivity of imaging systems is a luminescent converter.

The major characteristics of fluorescent converters are rentgenolyuminestsentsium brightness and resolution. Brightness is determined rentgenolyuminestsentsium conversion efficiency of a luminescent material and the efficiency of absorption of X-rays. [2]

The resolving power of fluorescent converters rather complex way depends on the thickness and size of structural inhomogeneities of the luminescent layer. This structural heterogeneity are major contributors to reduced flaw sensitivity introscopes because a local spatial heterogeneity modulated radiation absorption and, consequently, the distribution of brightness. For example, if the thickness of the luminescent layer converters radiation 100мкм for contrast sensitivity to 0,1% of the structural heterogeneity should be less than 1 micron. Existing methods of manufacturing luminescent converters, in particular, the screens of polycrystalline phosphors do not allow for such precision and lack of structural noise. In particular Figure 2 shows an image of the surface of the luminescent screen CsI (Tl) obtained using an interference microscope and the corresponding graph of surface irregularities obtained by the interference method.

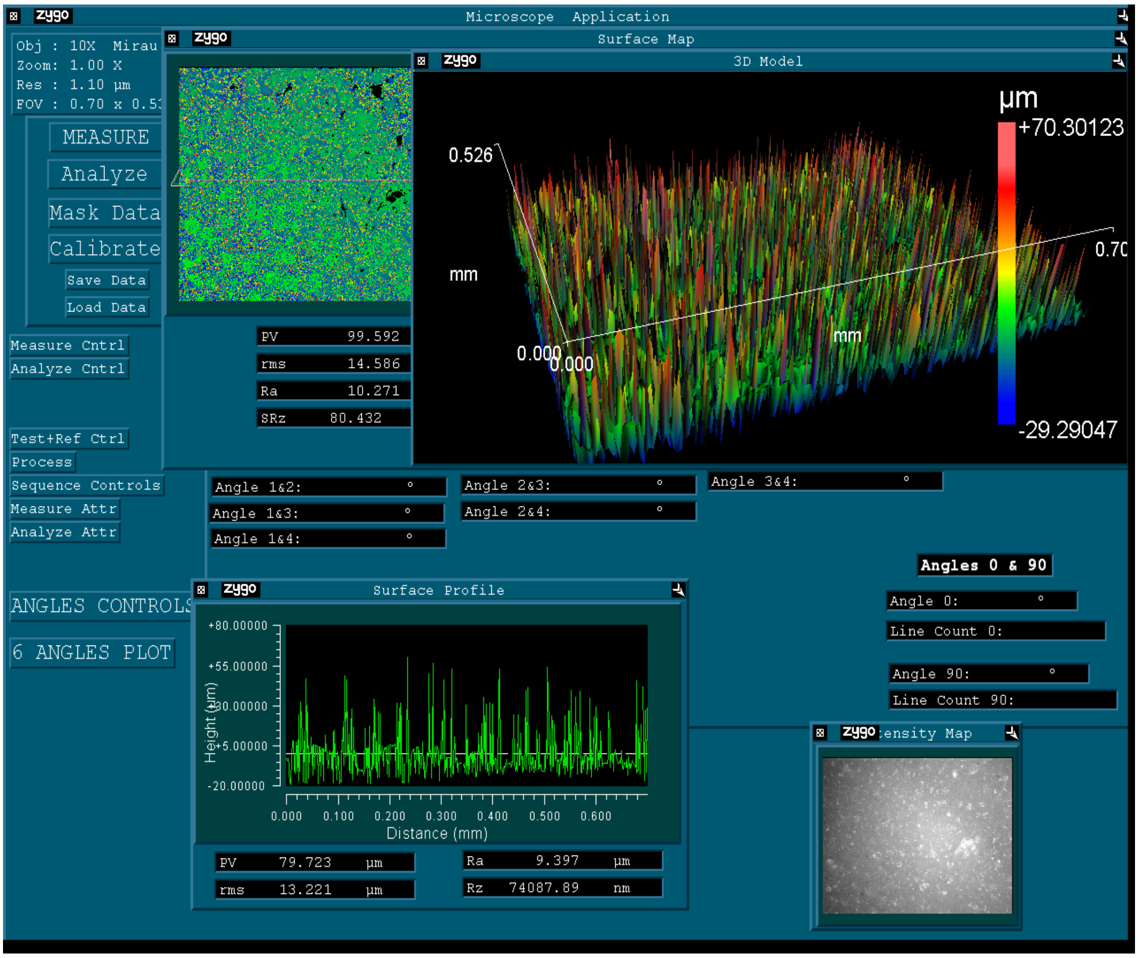

Figure 2. The structure of polycrystalline luminescent converter (CsI (Tl)) with a surface roughness up to 100 microns.

As follows from the results of research shows that the structural heterogeneity of fluorescent screens is about 100 microns for the CsI (Tl).
The magnitude of these inhomogeneities is determined by the grain size of phosphors and does not provide a high flaw sensitivity of imaging systems using similar transducers radiation.

At the same time is of interest to investigate the possibility of manufacturing light converter with high quality surface on the basis of single-crystal screens.

As the object of research, we chose samples of single crystals of CsI (Tl). Currently, CsI (Tl) is one of the best fluorescent material, as it combines the high conversion efficiency of conversion of energy absorption in the light rentgenolyuminestsentsium (19-20%), sufficiently high density (4.5 g/cm3) and the effective atomic Number (54). For surface treatment of CsI (Tl) we used the method of polishing using different emulsions.

Figure 3 is a graph describing the nature and structure of the crystal surface inhomogeneities CsI (Tl) before grinding.

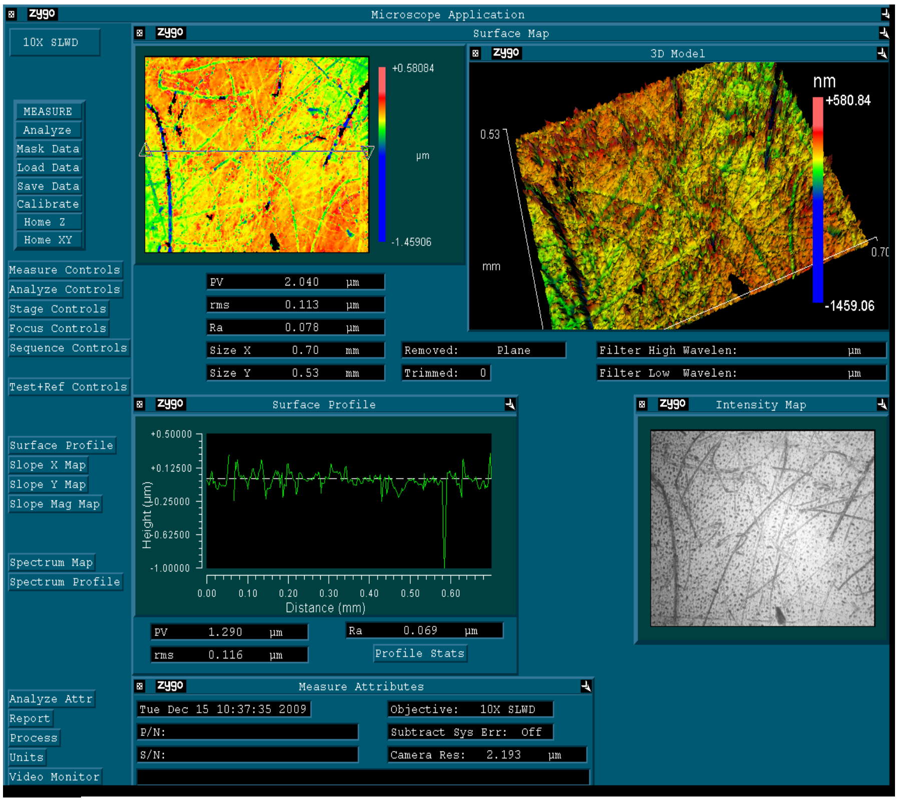

Figure 3. The schedule and structure of the crystal surface irregularities CsI (Tl) before grinding.

Figure 4 is a graph describing the nature and structure of the crystal surface inhomogeneities CsI (Tl) after grinding.

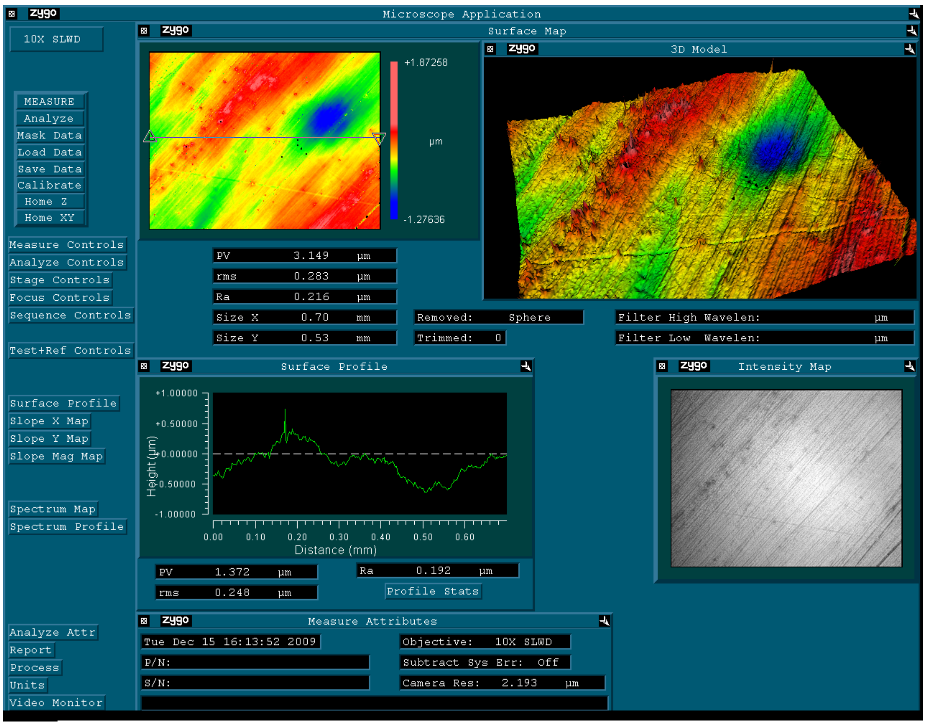

Figure 4. The schedule and structure of the crystal surface irregularities CsI (Tl) after grinding.

As can be seen from the graphs there are two types of irregularities polishing - regular (wave) with amplitude of ≈ 1 m and a period of 500 microns, and the roughness depth 0,05 - 0,1

mm.
Example study the surface quality of monocrystal luminescent converter based CdWO4 shown in Figure 5.

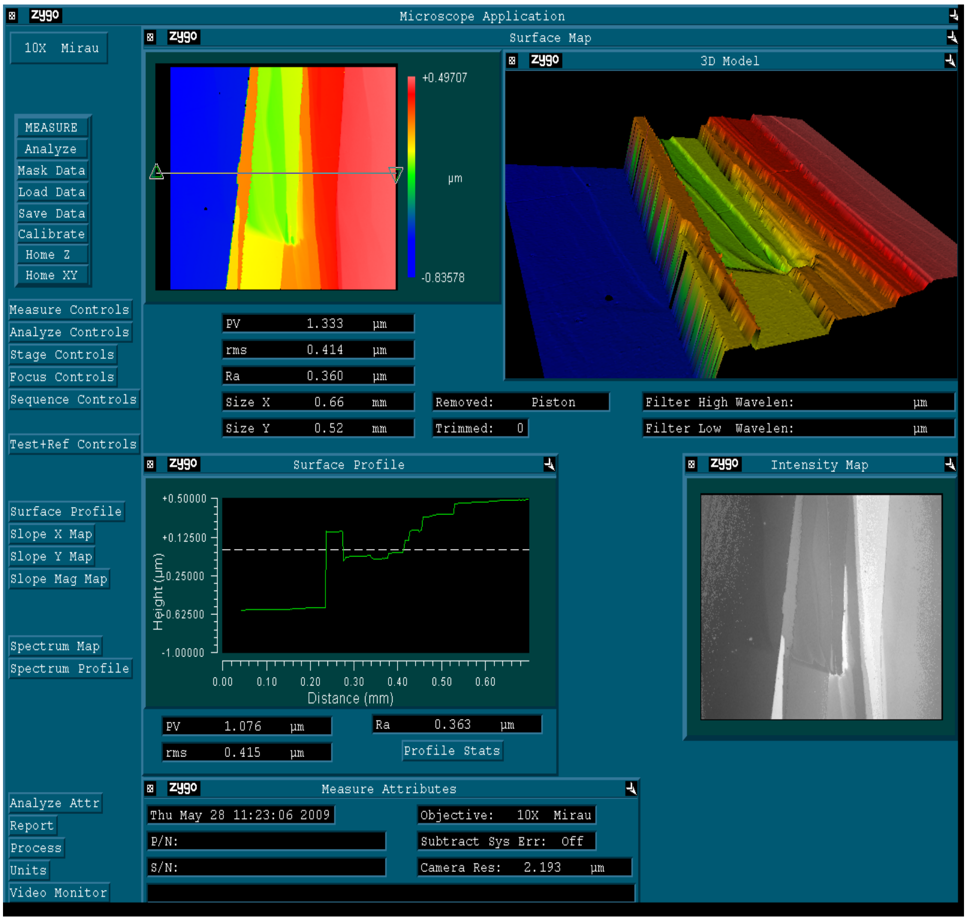

Figure 5. The structure of single-crystal luminescence converter with a height difference on the surface to 1 micron.

The results show that using converters based on single crystals can be obtained flaw sensitivity SRDC within 0,1-0,2% realize the limits of the CCD - camera.

In this case the use of optical interference microscope NewView 7300 enables effective process control quality surfaces fluorescent converters in their manufacture.

References

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