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Degradation of sensory elements induced by external potential

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Potentially induced degradation is the degradation of the silicon substrate or the functional layer of the sensor element formed on it, caused by the appearance of a potential difference between the substrate and the body under irradiation conditions in the visible and infrared range. This phenomenon has the greatest impact on IR sensors, lighting sensors and photocells, causing loss of efficiency of the latter due to the presence of leakage currents. This phenomenon affects the most common silicon-based solar panels. The degradation mechanism known as polarization in circuits having a positive voltage potential relative to ground was discussed in [1-4]. Structural failure is most common for crystalline silicon front junction (n–p) photoconverters, and develops most intensively when the modules are at a negative voltage relative to ground [5].

The decline in efficiency reaches 30% after 3 years of operation. The rate of degradation depends on the operating voltage of the system, humidity, and temperature of the elements. A special feature for photovoltaic panels is the occurrence of induced currents between the photovoltaic panels and the ground, which significantly increases the degradation of parts of the elements connected to the negative or grounded electrode (panel body). The PID phenomenon that occurs in modules with a negative polarity circuit can be completely avoided if the panel frame is made of dielectric, photo-thermal resistant materials with sufficient mechanical strength. There is also a known solution based on anodic grounding [6] to protect silicon wafers by shifting the electrochemical ground potential.

Unlike solar cells, the sensor area is much smaller, and it is necessary to control both the condition of the sensor layer itself and the condition of the substrate. There are several well-known methods for analyzing changes in the effectiveness of properties [7]. In our work, it was proposed to use thin films of molybdenum disilicide as layers of sensor elements, obtained by applying a metal coating accompanied by irradiation with ions of the same metal [8]. Ion bombardment during coating under ion-activated conditions provides mutual mixing at the metal/silicon interface [9]. This method of forming a coating on silicon is accompanied, among other things, by the formation of silicides and is of interest to researchers due to its potentially wide application in electronics. The developed and obtained thin films can find application in the creation of sensor micro-nanosystems for monitoring optical radiation, as well as in other sectors of the national economy, where the problem of converting optical parameters is extremely important and relevant.

In this work, coating-substrate structures were obtained containing molybdenum silicides, having a uniform distribution over the surface, high thermal stability of resistive properties (PID elements are up to 2.7 times smaller compared to other materials), with a wettability of 20^0, which is lower than that of the original substrates. Analysis of the results of hardness measurements showed that the hardness of the coatings themselves is 4.3 times higher than the hardness of the original silicon and is comparable to the hardness of diamond-like coatings and confirms the good strength characteristics of the resulting coatings. The results obtained show the possibility of forming an IR radiation sensor using a group method in the form of a chip cut from a silicon wafer with an increased service life.

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