Fullerene for semi-conducting photo- and light diodes (1.5–5.0 µm)

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Semiconducting IR photo- and light diodes for the 1.6–5.0 µm range are widely applied. They are especially required as a key component in gas analyzers for monitoring industrial and natural gases (methane, SiO_2, NO_2 etc).

It is known that the passivation methods are developed within opto-electronics. Passivaton helps prevent semiconductors from reactions with atmosphere and eliminate interface levels from the bandgap. It is known that that the passivation in alcohol sulphidic solutions improves the characteristics of *p–n* mesadiodes and IR InAsPSb/InAs photo diodes. Though, the surfaces treated this way are unstable. We sought the solution on the way of covering the surfaces of the diodes with individual fullerene C_{70} and with an extract of higher fullerenes C_{76}+ C_{78}+C_{84}+C_{90}+…. The fullerene material was obtained in "ILIP", Joint, SPb. The purity of the C_{70} fullerene was ~99%. On the contrary, in the C_{76} + C_{78} + C_{84} + … mix the higher fullerene content was ~ 98mas%, the light fullerenes played the role of the admixture.

We grew three types of photo- and light diode structures for 2–5 µm wavelength range based on the *n*-type InAs (100) substrates. Liquid- and gas-phase epitaxy (MOVPE) were used. From the structures grown photodiode chips were produced with using photolithography and liquid chemical etching. Then the fullerenes, preliminarily solved in toluene, were evaporated within a drying box to form a continuous dissolvated fullerene film on the solid chip surface.

The chips of 500×500 µm^2 obtained this way were soldered on TO-18 box. All the devices had diode type characteristics with cutoff voltage of ~ 0.4 V at RT and differential resistance of 1.0–1.2 Ohm. To determine the dark currents, reverse branches of I-V characteristic were measured before the covering, just after and the month since the procedure. When using the C_{70} fullerene as a passivating agent, the dark current for two types of the photodiodes (PD-36 and PD-46 for the 1.5–3.5µm and 1.5–3.5µm) reduced by 40 и 20% at standard reverse biases. In similar way, for the LED28 light diode the leak current reduced by 20%, the resistance doubled. The radiation intensity for the V-2928 light diodes at RT increased by 17–18%. Similar result was registered for ohmic power within the whole working current range.

When using the heavy fullerene mix as a passivating agent, the results are similar. The dark current reduction in the PD-36 and PD-46 were ~ 11% and 14%. Besides that, a sample temperature decrease was found (the Peltier effect).