Part 8

RENEWABLE ENERGY SOURCES

8.3. Solar power plants and heat supply systems

8.3.1. Photoelectric converters and power installations on their basis

8.3.1.2. Multitransition (cascade) photoconverters

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Further increase in efficiency of PEC and power installations on their basis is connected with development and application of multitransition (cascade) SEs. Such elements have the extended range of spectral sensitivity in comparison with single-transition ones.

Recently this direction is especially intensively developed. Since 1996 two-cascade PECs on the basis of InGaP/GaAs are produced in the industrial scale. They were successfully applied in space. Industrial production of three-cascade PECs started in 1999 on the basis of InGaP/GaAs/Ge.

A decisive circumstance for economically sound application of multitransition SEs is that they can rather effectively operate at intensity of light streams, exceeding (in hundred and thousand times) the natural solar stream, that sets them apart from silicon PECs.

Nowadays high-efficiency multitransition elements are developed, that makes their application attractive enough either in space power systems, or in ground concentrating power installations. A process of producing such structures is complicated, expensive and requires application of high–technological equipment. In Europe and the U.S. installations of gaseous epitaxy of metal-organic compounds from steam are used for this purpose. These compounds allow renewable creation of multitransition and multi-layer heterostructures with the thinnest layers and stable parameters [13].

Prototypes and series-produced PECs with high efficiency (to 38%) were gained for light streams, equivalent to streams from the sources of radiation with capacity, multiple of hundred of suns. Data relating to theoretical and the most valuable reached figures of efficiency of cascade SEs (CSEs) are shown in table 8.5.

Cascade SEs allow to create high-efficient economic photoelectric power installations, operating at the concentrated solar radiation. Operational efficiency of such elements greatly depends on coordination of working parameters of separate CSE elements, which is kept only for the set conditions of exploitation. So, at selection of CSE type for concentrating installations, it is necessary to select a SE, optimized for operation in the required range of solar radiation concentration, in order to achieve the highest energy generation.

In Russia in Physical and Technical Institute of A.F. Ioffe single-transition AlGaAs/GaAs SE with efficiency of about 27,6 % at radiation concentration of 140 suns and 26,2 % at concentration of 1000 suns were produced. There were also produced mechanically joined CSEs on the basis of AlGaAs/GaAs – InP/InGaAs – (or GaSb) with efficiency of 32…33 % at hundredfold concentration of solar radiation.

Table 8.5. **Basic characteristics of cascade SE**

Manufacturer	SE structure	Multiplication of solar radiation concentration	Efficiency, %	Information source
Fraunhofer Institute for Solar Energy (IES)	GaAs	70	26,8	[14]
IES	GalnP/GalnAs	281	32,0	[14]
IES	GalnP/GalnAs/Ge	500	35,3	[14]
Sharp Corp.	GalnP/GalnAs/Ge	500	38,9	[15]
NREL	GalnP/GaAs/GalnAs	10	37,9	[16]
Boeing-Spectrolab	GalnP/GalnAs/Ge	175	37,3	[17]