Multijunction Solar Cell

BCSIR scientists have a pioneer role in the field of multijunction solar cell research in Bangladesh. Currently they are conducting research on the device physics, design, modelling and simulation of the performance of III-V bismide based novel multijunction solar cells. Previously they conducted intensive research on Germanium based GaInP2/GaAs/Ge multijunction solar cell. Their main focus is to attain highest theoretical efficiency of two, three and four junction solar cell by modeling and simulation. They have achieved 50% theoretical efficiency milestone by judicial material selection and device design. They are also engaging the one dimensional multijunction solar cell simulator (MSCS-1d) development. Their vision is to develop the high efficiency concentrator solar cell in Bangladesh and help the local industries to manufacture the multijunction solar panel.

R&D Project (Internal Grant of BCSIR)-

Tittle: Modelling and simulation of a high efficiency multijunction concentrator solar cell.

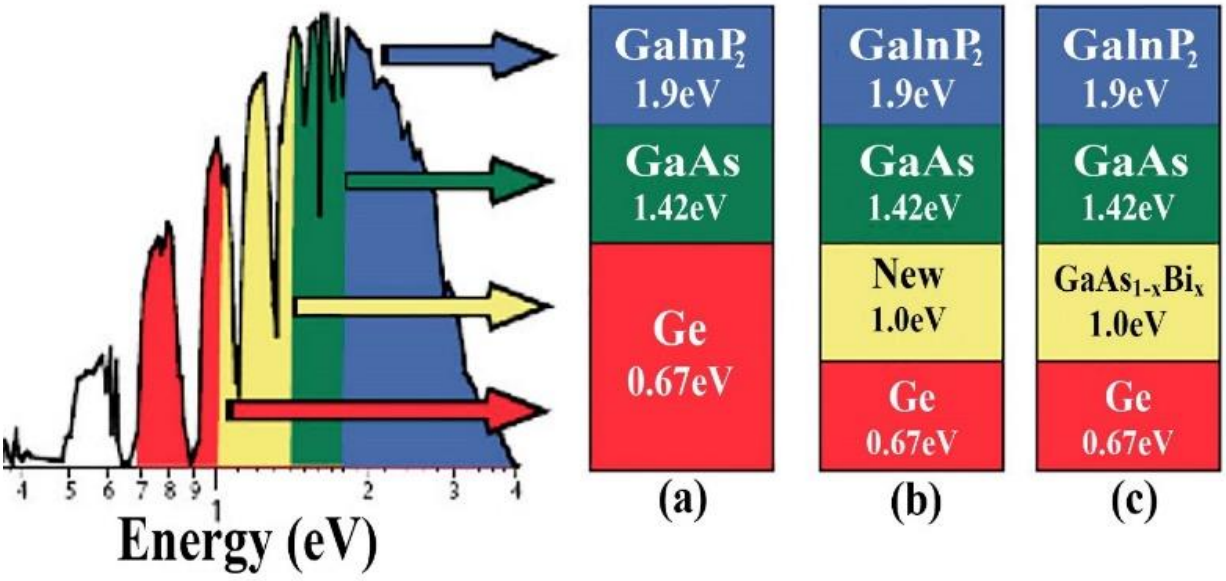

Figure. Different parts of solar spectrum absorbed by corresponding semiconductor materials are shown in (a)–(c). In (a), entire spectrum is absorbed by $GaInP_2$/GaAs/Ge solar cell. In (b) an additional 1eV bandgap new material is introduced and in (c), a $GaAs_{1-x}b_x$ semiconductor of 1eV bandgap material is used for achieving novel four junction concentrator solar cell.

Novel Material:

BCSIR scientists proposed a novelmultijunction solar cell, where all sub-layers were comprised of III-V semiconductor materials. They used $GaInP_2$ as first layer, GaAs assecond layer and Geas bottom cell or fourth layer. For third layer, they used Gallium Arsenic Bismide ($GaAs_{1-x}Bi_x$) for the first time and got very promising results.

Device design:

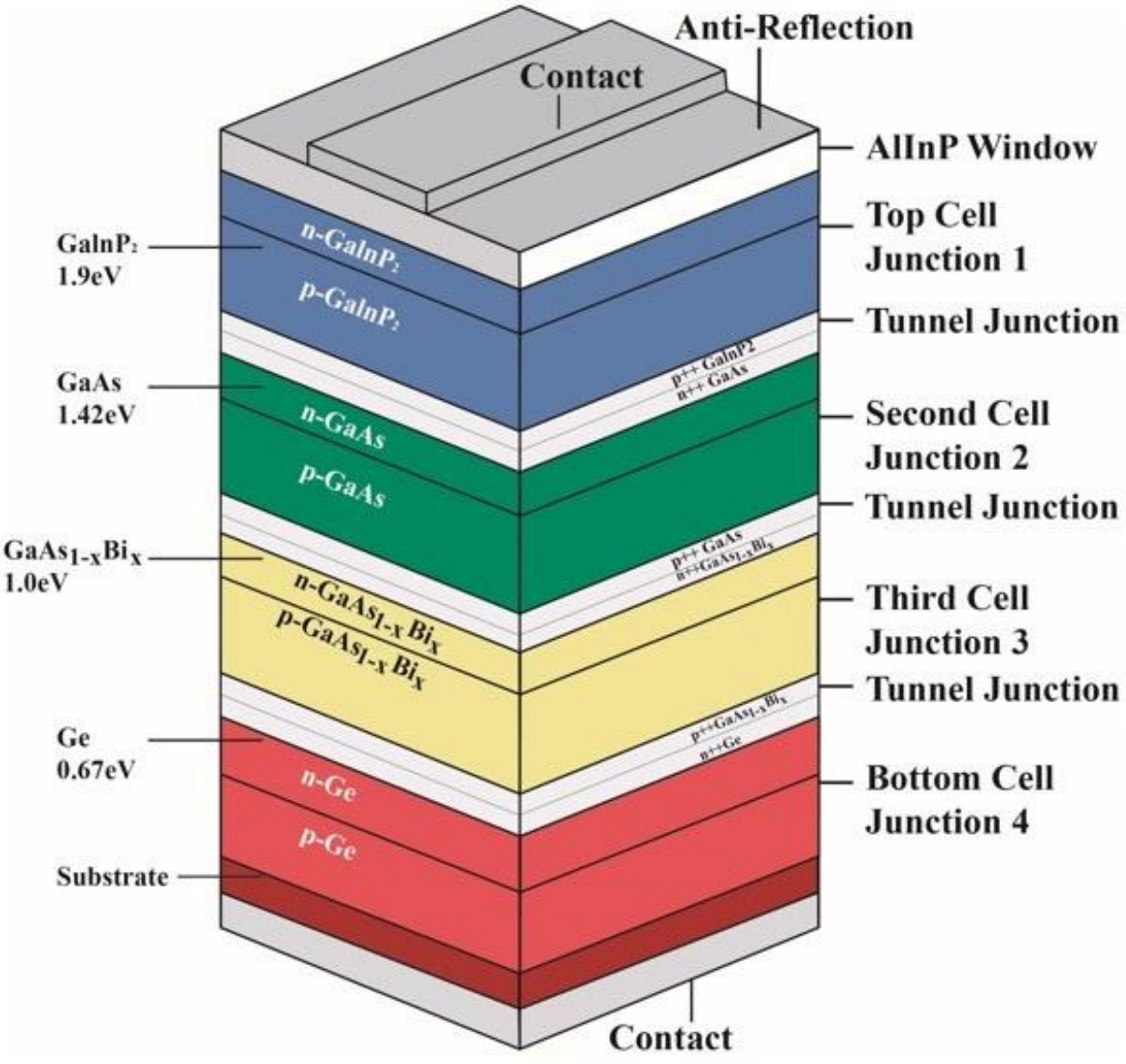

Figure. A schematic design of $GaInP_2/GaAs/GaAs_{0.94}Bi_{0.06}/Ge$ multijunction solar cell.

Theoretical Model:

In their current research and development project, they developed a theoretical model which is basically a modification of spectral p-n junction model proposed by Nell and Barnett. According to this model, the short-circuit current density, J_{sc}, has been calculated directly from the ASTM G173-03 reference spectra derived from SMARTS v. 2.9.2 (AM1.5). For evaluating of the impact of the sun concentration, an additional concentrator factor (C) is incorporated with the short-circuit current density, J_{sc}, equation of spectral p-n junction model. The open circuit voltage, V_{oc}, maximum voltage, V_m, maximum current density, J_m, fill-factor, FF and efficiencies have been calculated by using standard solar cell equations.

Ultra-high theoretical efficiency milestone!

They determined around 49% theoretical efficiency for airmass AM 1.5G at normal atmospheric condition and around 60% for concentrating condition. The following graph shows their sun efficiency versus concentration response.

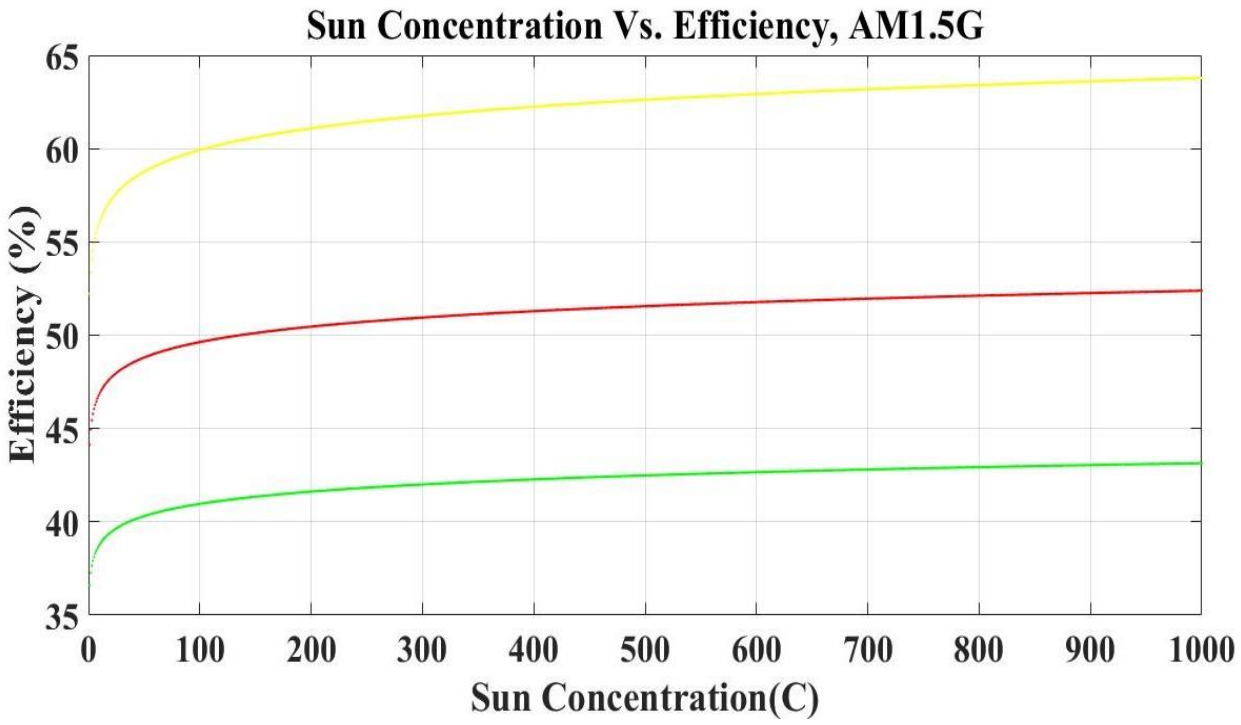

Figure: Sun concentration versus efficiency for AM1.5G. The top (yellow), middle (red) and bottom (green) curves are, respectively, for 4J, 3J and 2J multijunction solar cell.

Special allocation project: (External grant from Ministry of Science and Technology, Government of Bangladesh)

Tittle: Development of a one-dimensional multijunction solar cell simulator (MSCS-1d)

Scientist of IPD, BCSIR developed a theoretical model and based on this model, a preliminary version of one dimensional multijunction solar cell simulator (MSCS-1d: V-1) is under construction. In our on-going project, our intention is to resolve the technical problems of the preliminary version, and develop a more efficient simulator for multijunction solar cell using Java programming language along with the help of PHP and *.net framework. Basically this simulator could simulate all required standard equations and automatically generate all types of optoelectronic properties such as cell short-circuit current density, open circuit voltage, dark current, bandgap, thickness, width, temperature, mobility, surface recombination velocity, maximum power, fill-factor and efficiency of a multijunction solar cell that is crucially required for solar panel fabrication.

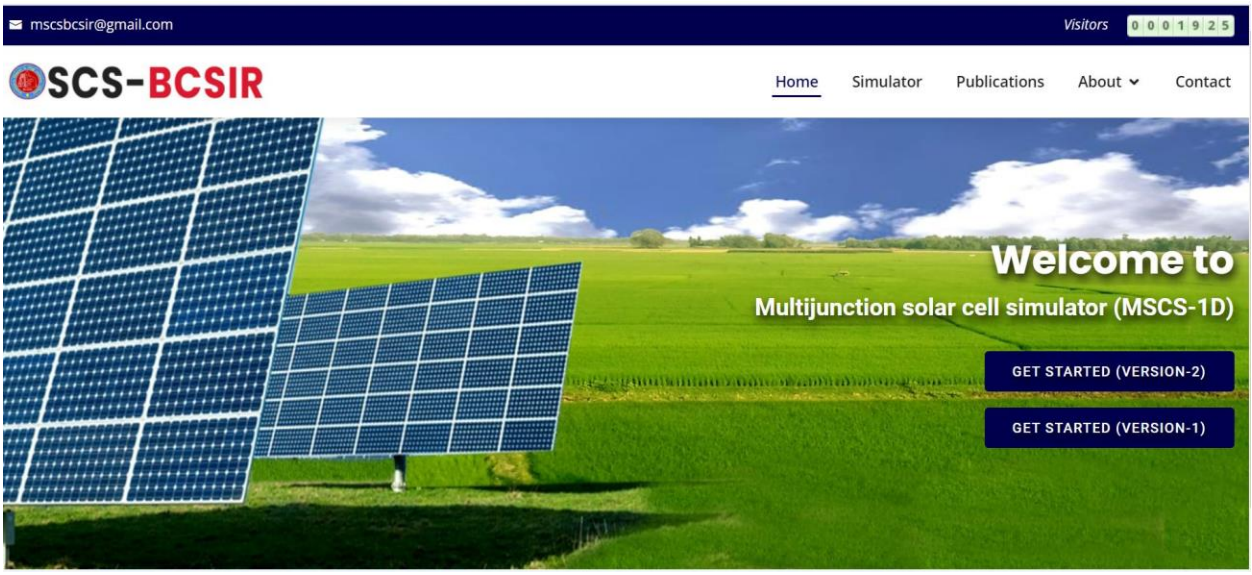

Fig. Home page of MSCS-1D simulator

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