《New Concept in Photovoltaic Energy (storage technique)》 Glossary

Band gap:【バンドギャップ】
Semiconductors are materials in which the range of excitation energies is separated by the band gap (E_g). The energy range below the gap, which is called as valence band, is occupied with electrons. The energy range above the gap, which is called as conduction band, is nearly empty. The photons having energies higher than at least the band gap energy can be absorbed by semiconductors, generating electrons and holes in the conduction band and valence band, respectively.

Conversion efficiency:【変換効率】
The conversion efficiency is defined as a ratio of the maximum power output of the solar cell to the incident power of solar illumination. Solar cells for terrestrial application are usually measured under air mass 1.5 (100 mW/cm^2) illumination condition. Air mass 1.5 (AM1.5) corresponds to an angle of incidence of solar radiation of 48^o relative to the surface normal. The energy of AM1.5 is regarded as the standard spectrum for measuring the efficiency of solar cells used terrestrially.

Crystalline silicon solar cells: 【結晶シリコン太陽電池】
Fabrication of crystalline Si solar cells from either single crystalline or multicrystalline wafers is a mature technology that is currently entering large-scale production all over the world. These solar cells have advantages of high efficiency potential, material abundance, ability of research sharing with the microelectronics market. However, about 200-μm-thick silicon wafers are produced by silicon purification, ingot growth and dicing process, which takes about half of the cost of the complete solar cells.

(Hydrogenated) Amorphous silicon:【(水素化) アモルファスシリコン】
Amorphous silicon is a non-crystalline material that exhibits a structural disorder over a long range of atomic arrangement. Amorphous silicon contains high density of dangling bond defects and cannot be used as a semiconductor. Nevertheless, the inclusion of about 10 at.% hydrogen serves to saturate the defect density by more than 4 orders of magnitude and the resulting films (hydrogenated amorphous silicon: a-Si:H) can be used as semiconductor devices such as solar cells and thin-film transistors.

(Hydrogenated) Microcrystalline silicon:【(水素化) 微結晶シリコン】
Hydrogenated microcrystalline silicon (μc-Si:H) is known as a heterogeneous material that contains nanometer-sized (~10-50 nm) crystals packed with amorphous silicon

tissues intro conglomerates. The materials contain a large number of grain boundaries but they are well passivated by the presence of hydrogenated amorphous silicon tissues. This is one of the reasons why the material exhibits device quality in spite of the extremely small grain size. The optical properties are similar to those of single crystalline silicon.

Light management (light trapping)：【光マネージメント（光閉じ込め）】

In a-Si:H solar cells, it is necessary to keep the absorber thickness very thin in order to obtain a strong electric field, thus to reduce the light-induced degradation. Such thin a-Si:H solar cells absorb only a relatively small part of the incident light. On the other hand, the μc-Si:H is an indirect band gap material and thus has low optical absorption coefficient in the infrared region. Therefore, the light trapping in these thin film layers by using textured substrate is one of the most important subjects for the achievement of high efficiency. The key requirement for the textured substrate is to realize the effective light scattering at substrate surface in order to enhance the path length of the weakly-absorbable lights in thin film layer.

Light-induced degradation:【光誘起劣化】

In hydrogenated amorphous silicon (a-Si:H), the saturation of dangling bond defects by hydrogen is not totally stable. When the a-Si:H is exposed to light with photon energies higher than the band gap (~1.7 eV), the degradation of electrical transport properties takes place. The weaker bonds within the amorphous silicon network are broken by the illumination and therefore new dangling bond defect are created. When the defect density in amorphous silicon is increased by light exposure, the recombination of photo-generated carriers increases and, at the same time, the built-in electric field in the i layer weakens. As a result, the fill factor (FF) of solar cells substantially decreases, causing a drop in conversion efficiency. The light-induced change in material and device properties is completely reversible by the thermal annealing at ~150 ^{o}C.

Multijunction (tandem) cells:【多接合（タンデム）型太陽電池】

The conventional solar cell, e.g., p-n junction crystalline silicon, has a single band gap E_g. A photon energy less than E_g can not be absorbed (non-absorption loss). Meanwhile, a photon with energy higher than E_g can be absorbed in the material while the excess photon energy over E_g is wasted as heat (thermalization loss). These two are the primary losses of energy conversion efficiency from sun light to electricity. The improvement in the absorption and the reduction of thermalization losses can be simultaneously achieved by employing multijuction solar cells with (at least two) different band gap subcells that are stacked in order from the widest gap for illumination side toward the narrowest gap at the bottom of the device.

（Photovoltaic）Solar cells: 【（光起電力性）太陽電池】

Photovoltaic solar cells convert solar radiation into electric power. Solar cell is made of a material that absorbs a part of the solar spectrum. In general, solar cell consists of a pn junction diode using various semiconductor materials such as silicon, gallium arsenide, cadmium telluride, copper indium selenide, organic dyes etc. The absorption of lights in semiconductor generates electrical charge carriers (electrons and holes). The photo-generated charge carriers produce an electrical current and a voltage when they are separated across the pn junction.

Plasma-enhanced chemical vapor deposition:【プラズマ援用化学気相堆積】

Plasma-enhanced chemical vapor deposition (PECVD) is a process that grows thin films from a gas state (vapor) to a solid state on a substrate. The a-Si:H and μc-Si:H can be deposited by the PECVD process at low temperatures (~200 ^{o}C) from the gas mixture of silane (SiH_4) and hydrogen (H_2) The plasma is generally created between two parallel electrodes by applying radio frequency (rf: ~13 MHz) or very high frequency (VHF: 60-100 MHz) excitation power.

Silicon-germanium alloys:【シリコンーゲルマニウム合金】

Since the crystalline SiGe alloy system exhibits completely miscible over the entire compositional range, the band gap can be tuned systematically in the range from 1.1 to 0.67 eV by simply changing the Si/Ge compositions. This offers an advantage over pure silicon in attaining high infrared sensitivity.

Thin film silicon solar cells:【薄膜シリコン太陽電池】

Thin film silicon solar cells typically consist of amorphous silicon and microcrystalline silicon layers. They have a p-i-n junction structure in which about 200-3000 nm-thick light-absorbing layer (i layer) is sandwiched between the thin (~20nm) doped p and n layers. The built-in electric field produced in the i layer extracts the photo-generated carriers from the front and back electrodes. Generally, thin film silicon solar cells incorporate a transparent conductive oxide layer as the front contact material, such as SnO_2, ZnO and indium-tin-oxide (ITO).