Area: 1

DEVELOPMENT OF HIGH EFFICIENT AND LONG-TERM RELIABLE CRYSTALLINE SILICON SOLAR CELLS AND MODULES BY LOW COST MASS PRODUCTION PROCESS

Yuta Irie, Junichi Atobe, Hiroaki Takahashi, Kouichirou Niira, Manabu Komoda, and Kenji Fukui

Kyocera Corporation

In Japan's NEDO project, the PV electricity price targets are 14 yen / kWh in 2020 and 7 yen / kWh in 2030.

To reduce PV electricity generation cost, the high efficiency and long-term reliability are indispensable for the PV module with low cost mass production process.

In a high quality and low-cost crystal growth technology development, we developed high quality multi-crystalline casting process by seed-cast method. In the present cell process based on the PERC solar cell using the seed-cast wafer, it was 20.2% of efficiency (in-house measurement).

We performed device simulation for power loss analysis of the cell and found rooms for the improvement of the recombination loss at the passivated surfaces and the electrodes on both of front and rear side.

Furthermore, as a result of having pushed forward process improvement of the recombination loss at the passivated surfaces and the electrodes of front side in the PERC solar cell, we achieved 20.5% (AIST measurement) by the seed-cast wafer.

In order to incorporate the future quality at the present time, it is necessary to design the cell & module and the reliability test method & conditions based on the scientific approach to the degradation mechanisms.

In this conference, we present PV module reliability lifetime prediction simulation results based on the degradation mechanism analysis for two of the major degradation modes in the market field. The first (A) is electrode contact degradation due to UV light and temperature & humidity stress, and the second (B) is PID due to high potential difference stress.

A is attributed to the acetic acid produced by the acid catalytic hydrolysis reaction of EVA. The acetic acid corrodes the thin glass layer between the interface of metal electrode and semiconductor silicon. UV light and formulation of additives in the encapsulant material greatly affects the life of the contact electrical quality of metal electrode.

Our newly developed simulation predicts that a field lifetime of PV modules more than 35 years can be realized by appropriate cell & module design including additive formulation balance.

B is attributed to the impurities such as Na that form shunt leak paths in the pn junction in the cell. Our newly developed simulation predicted that proper design of encapsulating materials and SiN film physical properties makes shunt resistance saturated at a certain level that result in our PV modules PID-free in the field environments.

This paper is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).