Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg

Physikalisches Institut

PHYSIKALISCHES KOLLOQUIUM

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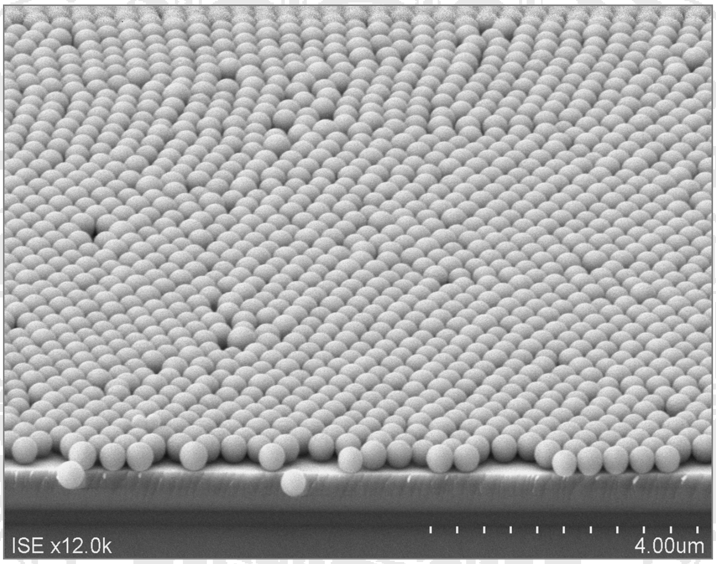
IM GROßEN HÖRSAAL



Self-organized opaline structures on the rear side of a crystalline silicon solar cell to reduce optical losses.

CRYSTALLINE SILICON SOLAR CELLS – LOSS MECHANISMS AND STRATEGIES FOR IMPROVEMENT

DR. STEFAN GLUNZ

FRAUNHOFER ISE, FREIBURG

At present, the photovoltaic (PV) industry is experiencing turbulent times, evidenced by the ups and downs on the global market. In the last years, the price of PV modules fell sharply which, on the upside, allowed to strongly increase the amount of photo-generated electricity. However, on the downside the price margins are vanishing, or even turning into losses, which hurts PV companies severely. In times of such hard competition, reducing production costs and improving the cell and production technology is crucial. In fact, great progress has been made in improving industrial solar cell structures based on crystalline silicon which is the dominating PV technology with a market share of around 85%.

The most essential approach for improvement is to achieve higher conversion efficiencies at a reasonable cost level. Reducing the optical losses and charge carrier recombination are the key factors to accomplish this goal. Consequently, it is substantial to understand the limiting loss mechanisms in a solar cell. Using such an in-depth loss analysis and improved cell architectures, it is possible to get closer to the physical efficiency limit of crystalline silicon solar cells of 29.4%. This theoretical efficiency limit is mainly determined by thermalization and non-absorption losses and by Auger carrier recombination. To achieve higher efficiencies than this limit, it is necessary to design tandem solar cells with two band-gap semiconductors on top of each other. Although this is nowadays mainly realized by using III-V semiconductors, also all-silicon tandem solar cells are feasible enabled by silicon quantum dot structures.