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Si nanowires prepared by a novel etching techique to standard crystalline silicon solar cells

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Abstract:

Semiconductor nanowires have taken much interest over the last several years for their novel applications in optoelectronic devices. Being the main material of today's electronic and photovoltaic industry, Si based nanowires receive special interest among other semiconductor nanowires. Si nanowires can be used on the surface of c-Si solar cells either as a an efficient light trapping medium on the surface, or they can be used as the active part of the devices like in the heterojuciton solar cells fabricated with either organic or inorganic thin film materials. Solar cells fabricated directly in the nanowire with either radial or axial p-n junctions formation have also been proposed recently. For a reliable and efficient use of Si nanowires in these applications, the geometry and the impurity doping should be controlled in a reproducible way. Moreover, a large scale industrial application requires the ability of the production over the area of industrial solar cells. Such an application also requires an easy implementation of the production processes with a low additional production cost that can be compensated by the improvement in the solar cell efficiency. Having the same physical properties as the Si substrate, Si nanowires produced by electroless etching method offer great advantage over other production methods. By this novel method, the area that can be decorated by nanowires is limited only by the size of substrate available.
In this study, we have produced nanowires by using electroless etching method on standard multicrystalline and monocrystalline silicon wafers with industrial size (15.6x15.6 cm2) at the c-Si production line of the Center for Solar Energy Research and Application (GÜNAM). Silicon wafers were decorated with various lengths of nanowires with different electroless etching time at room temperature. The measurements showed that the reflectivity could be reduced effectively as a result of superior light trapping property of nanowires. The ability of light trapping is shown to be depending on the wires lengths. It is well known that reflection losses is one of the major efficiency losses in the solar cells, and silicon nanowires can be very good candidate as an antireflective layer on the solar cells. We have demonstrated that full-scale solar cells can be fabricated on the Si wafers decorated by Si nanowires. The additional process step introduced into the production line comprises a wet etching process only. Our preliminary results show that the nanowire layer improves the cell properties especially short circuit current levels compared to those without nanowires. This promising result has been achieved without any particular optimization.