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Black “sand” and ultrathin films will allow the development of future high-efficiency solar cells

Title	Atomic layer deposited alumina on black silicon: passivation, electrical properties and application to high-efficiency solar cells Atomikerroskasvatetulla alumiinioksidilla passivoitu musta pii: sähköiset ominaisuudet ja soveltaminen tehokkaihin aurinkokennoihin
Content	Micro- and nanotechnology techniques have existed in electronics for several decades and have made possible the development of modern computers, mobile phones and of a multitude of other devices. As surprising as it may seem at first, those technologies have enabled the outbreak of another field: solar energy technology. This thesis studies the use in solar cells of atomic layer deposition and of black silicon, which have been developed and applied in the electronics industry and show great potential for photovoltaics. The large surface area intrinsic to solar cells can be problematic as it causes the loss of light-generated charges (e.g. electrons), and eventually decreases the amount of harvested energy. This is especially true for black silicon cells, consisting of micro- or nanostructures, which display even larger surface area than standard cells. Consequently, this thesis studies the possibility to apply black silicon and atomic layer deposition to functional solar cells and to explain the mechanisms of charge carrier loss at the surface. This work demonstrated that black silicon can be compatible with high solar cell efficiencies, as long as a conformal dielectric film providing a high static electric charge is present at its surface. This can be achieved by atomic layer deposition of alumina. Black silicon solar cells fabricated in this work displayed a record efficiency of 22,1 %, partly owing to the strong effect of the surface electric field. Finally, the physical loss mechanisms were studied in black silicon doped with a large content of boron atoms, which is beneficial for other solar cell technologies. This work demonstrated the high potential of alternative techniques for solar cell fabrication. Black silicon can be applied to various solar cell technologies with the help of atomic layer deposition.
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