Seminář odd. 26
Tenkých vrstev a nanostruktur

Fyzikální ústav AVČR, Cukrovarnická 10, Praha 6

datum: 14. 7. 2015 úterý
čas: 10:00
místnost: knihovna, budova A, 1.p.

TÉMA

Radial junction architecture: a new approach for stable and highly efficient silicon thin film solar cells

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Owing to their enhanced light trapping and anti-reflection effects, silicon nanowires (SiNWs) provide an effective research platform for developing a new generation of low-cost and high efficiency solar cells. By decoupling the light absorption and carrier collection directions in radial configuration, SiNWs facilitate the use of very thin intrinsic layers for PIN radial junction thin film solar cells. Apart from reducing the material consumption, using a thinner absorber layer provides a higher built in field and hence a better separation of carriers.

By optimizing the density of radial junctions, we have managed to achieve an initial efficiency over 8% with just 100 nm thick intrinsic hydrogenated amorphous silicon (a-Si:H), which is far less than the 250 nm typically used for cells deposited on textured substrates. We have also shown that such ultra-thin absorbers limit the light induced degradation to ≤ 6%, compared to 15-20% observed for planar junctions. Replacing the top layer by a more transparent hydrogenated microcrystalline oxide (n-type μc-SiOx:H) enhances the response of the cell in the blue spectral range and improves the efficiency up to 9.2%.

We have demonstrated the device performance for radial junctions constructed with lower band gap materials (μc-Si:H and a-SiGe:H) to take the advantage of the broader solar spectrum. The deposition of μc-Si:H is very sensitive to the surface roughness, making the deposition on SiNWs challenging. The material quality is analysed using Raman spectroscopy and transmission electron microscopy to provide guidance for growth optimization.

Finally, we shall also explore the feasibility of combining lower band gap a-SiGe:H bottom cell with a-Si:H top cell in a radial tandem junction.

odborný garant: *RNDr. Antonín Fejfar, CSc.*