Abstract

The method of template wetting allows one to fabricate highly ordered arrays of upright standing nanowires or nanotubes from different materials in a controllable manner. In this method, a porous template is filled by an appropriate solution or melt. After selective removal of the template, arrays of nanowires or nanotubes are obtained. Such arrays can be subsequently integrated into e.g. solar cells and other electronic devices.

This thesis is focused on the fabrication of thin-film porous anodic alumina (PAA) templates on different substrates. The fabrication of organic nanowires and nanotubes via melt- or solution-assisted wetting of PAA templates is also studied.

Supported PAA templates were obtained by anodization of thin Al films. Thin Al films produced by evaporation of Al onto different substrates were studied by SEM and AFM. It has been found that the structure and surface morphology of these films depend strongly on the deposition rate, temperature and type of the substrate. In general, maintaining low deposition rate, low substrate temperature and low residual gas pressure allows the fabrication of smooth Al films with low grain size.

The formation of thin PAA films on different substrates (silicon, glass, ITO-glass, mica) and in different electrolytes (oxalic, sulphuric and phosphoric acid) was also systematically studied. It has been found that the structure of such films depends strongly on the structure and morphology of the initial thin Al films as well as on the anodization conditions. Anodization of smooth Al films at optimum conditions leads, in turn, to the formation of highly ordered PAA structures which can be successfully used as templates for the growth of organic nanowires and nanotubes.

A novel method for the fabrication of thin-film PAA templates on free-standing thin-film substrates was developed. The method involves the use of water-soluble NaCl release layer produced by means of e-beam evaporation in high vacuum. The PAA templates are fabricated via anodization of thin Al films supported by thin layers of e-beam evaporated silicon oxide or aluminum oxide.

The prepared thin-film PAA templates were directly used for the fabrication of poly(3-hexylthiophene) (P3HT) nanotubes by means of melt-assisted wetting. Different architectures of solar cells based on P3HT nanotube arrays and thin films of PCBM were considered.

Additionally, 1D nanostructures from P3HT, poly(9,9-dioctylfluorene-2,7-diyl) (PF8), 2,7-diphenylcarbazole (DPC), zinc phthalocyanine (ZnPc) and perylene-tetracarboxydiimide (PTCDI) were obtained by melt- and/or solution-assisted wetting of commercial PAA membranes (Anodisc^{TM}). Since DPC nanowires were fabricated for the first time by this technique, their morphology and optical properties are discussed in detail.