Deposition of APTES-modified silver nanowires for highly stable, conductive, and transparent electrodes with strong adhesion

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We report metallic nanowire films with strong adhesion for promising transparent conductive electrodes using silver nanowires (AgNWs) treated with (3-aminopropyl)triethoxysilane (APTES). We functionalized surface of AgNWs to be positively-charged with amine group by treating poly vinylpyrrolidone (PVP) capping layer of AgNWs with APTES. The APTES-modified AgNW films were fabricated by simple coating process using meniscus-dragging deposition (MDD) technique. The resulting AgNW films have strong adhesion because the positively-charged surface of nanowires electrostatically interacts with negatively-charged surface of glass substrate hydroxylated by piranha treatment and also with surface of poly ethylene terephthalate (PET) substrate having high surface energy by plasma treatment. By controlling conditions of the coating process, the optical and electrical properties of the films can be finely tunable exhibiting sheet resistance of 6-22 Ω/sq at high optical transmittance with strong adhesion. The properties of the APTES-modified AgNW thin films were well described theoretically by confirming the percolation theory in a two-dimensional matrix model and figure of merits.