Preparation of functional inkjet inks for multi-functionalization of fabrics: I. Surface modification of TiO$_2$ nanoparticles with silane coupling agent

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Due to the excellent photo-catalytic activities making TiO$_2$ nanoparticles applicable in many fields such as self-cleaning, anti-bacterial agent, UV protection and environmental purification [1], a great potential for multi-functionalization of fabrics by TiO$_2$ nanoparticles is observed. Inkjet printing technique can be used as a novel approach with high efficiency and low cost to deposit TiO$_2$ nanoparticles on fabric surfaces.

In this study, in order to prepare a functional inkjet ink with high affinity between particle modifiers and fabrics, the surface of commercial TiO$_2$ nanoparticles was modified by 3-aminopropyltrimethoxysilane (APTMS) and 3-Isocyanatopropyltrimethoxysilane (IPTMS) by an aqueous process. The grafting efficiency at various reaction time, temperature and concentrations of APTMS and IPTMS on the TiO$_2$ nanoparticles surface was characterized by thermal gravimetric analysis (TGA). The interfacial structure of the modified nanoparticles was characterized by Fourier-transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). The size and zeta-potential of original and modified TiO$_2$ nanoparticles were measured by dynamic light scattering (DLS) technique. Dispersion stability of different TiO$_2$ nanoparticles was evaluated by zeta-potential measurement in various organic solvents. The results obtained confirmed that the organic functional groups were grafted on the particle surface for both APTMS and IPTMS modified TiO$_2$ nanoparticles and the chemical bonding of organosilane onto nanoparticles surfaces was realized through Si-O-Ti bonds. The size of nanoparticles was significantly dependent on the grafting efficiency of silane coupling agent. The dispersion stability indicated that the surface modification by silane coupling agent can lead to an improvement of nanoparticles stability in polar organic solvents.