

THETA Technology: Molecular solutions of metal oxides

THETA's solubilising technology produces hybrid organic-inorganic metal oxide material that forms homogenous solutions in common solvents without the need for additives such as dispersants for stability. The minimisation of particle size growth during synthesis and the coordination of organic acids is utilised to generate these solutions. The reaction of hydrous metal oxide with simple carboxylic acids produce surface bound carboxylates in a number co-ordination modes including hydrogen bonding, mono-dentate, bi-dentate bridging species, see Figure 1.

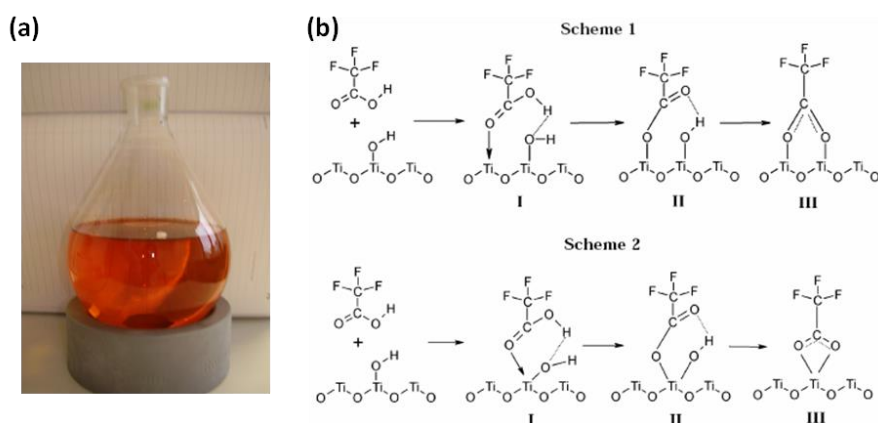


Figure 1.(a) Solution of Metal Oxide and (b) Coordination modes of trifluoroacetic acid with hydrous titanium dioxide

The <5nm diameter size of the metal oxide particles following synthesis enables excellent solubility with surface bound carboxylate groups (e.g. -CF₃) interacting with the surrounding solvent molecules. By varying the organic acid (e.g. acetic acid) different patterns in solubility in different solvents are produced due to a combination of electronegativity, acidity, di-pole moment etc. The flexibility of the soluble material enables unparalleled doping of both metal and non-metal elements (e.g. niobium, tungsten, fluorine etc.) that cannot be introduced using other technologies, see Figure 2. This lends to new and exciting surface applications.



Figure 2.Undoped and metal doped SnO₂

Traditional TiO₂ products are produced in colloidal solutions or Sols. TiO₂ produced by THETA on the otherhand has the ability to fully dissolve in common solvents. Traditional colloidal solutions of TiO₂ involve dispersion rather than dissolving of particles throughout a liquid. These TiO₂ particles are much larger than those found in true solutions but remain suspended in the liquid due to charge interactions or by the addition of additives such as dispersants.

Our technology enjoys increased processability by producing nano-particles in their final form that allows solution based processing. Solubilisation is a simple one step process with reduced cost without any necessity of chemical dispersants to ensure their stability. Also, the presence of additives during film formation can lead to chemical impurities that could be incorporated into the film. These impurities can have a detrimental effect on the functionality of the films. Film formation involves simple solution based methods such as spray or dip coating followed by sintering. Due to the presence of preformed nano-particulate metal oxide during deposition isotropic uniform crystal growth is witnessed during annealing. As a consequence very smooth, densely packed metal oxide films are formed asillustrated in Figure 3.

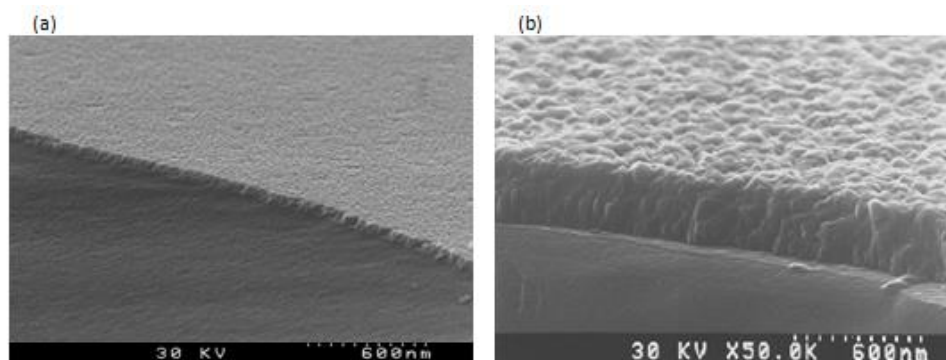


Figure 3.(a) film produced by solubilising process and (b) commercially available film

The increased film smoothness and uniformity produces films with exceptional clarity with reduced haze easing any effect on the aesthetic quality of the underlying substrate. Conversely, commercially available films with their surface roughness diffract light reducing the transparency and affecting the substrates visual quality. These outstanding physical properties result in durable, smooth films in excess of current market offerings.