



## Studying Titania Coatings

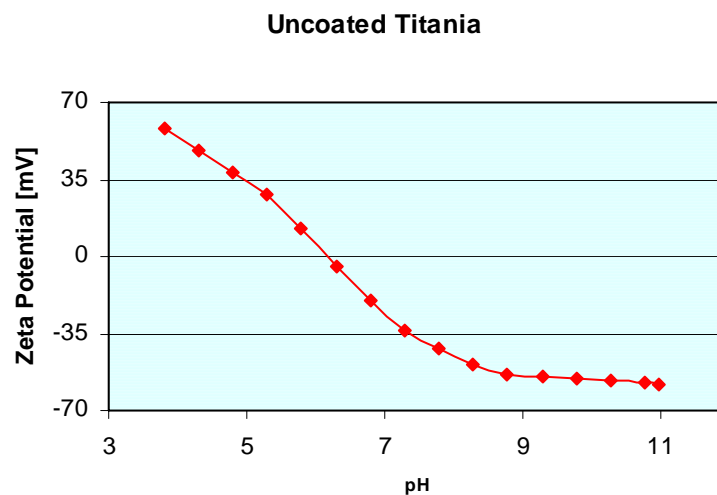
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### Abstract

Describes the use of the ZetaProbe and the AcoustoSizer in studying the coatings on titania particles.

### 1 Introduction

Titania ( $\text{TiO}_2$ ) is a white pigment and an important industrial material, widely used in the paint, ink, paper, synthetic fibre and even cosmetic industries. It is used as a coating, a reflecting agent or as a scatterer/absorber of light. It has one significant drawback and that is that it is photoactive. That is, when it is acted on by light it can release an electron from its surface and that electron may cause chemical damage to the surrounding material. For this reason, the titania particles are usually covered with a thin coating of some other oxide, like silica, alumina or zirconia or a combination of them.

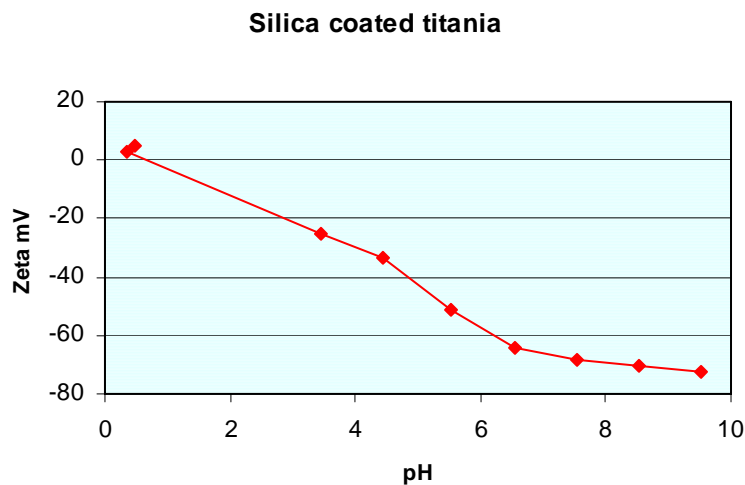


**Figure 1** Titration curve for uncoated titania

## 2 Titration Using the ZetaProbe

One can sometimes identify the outer coating by titrating the suspension with acid and base to determine where the zeta potential becomes zero. This is called the isoelectric point (i.e.p.) and for clean titania it is around pH 6, for silica about pH 2 and for alumina about pH 9.

In the figure 1 we show the curve of zeta vs pH for an uncoated titania. Such a curve can be obtained in under half an hour on the ZetaProbe.



**Figure 2** Titration curve for silica coated titania

The isoelectric point is 6.2 in this case. In figure 2 we show the titration curve for a silica coated sample. The iep has been shifted to the very low values typical of a silica surface.

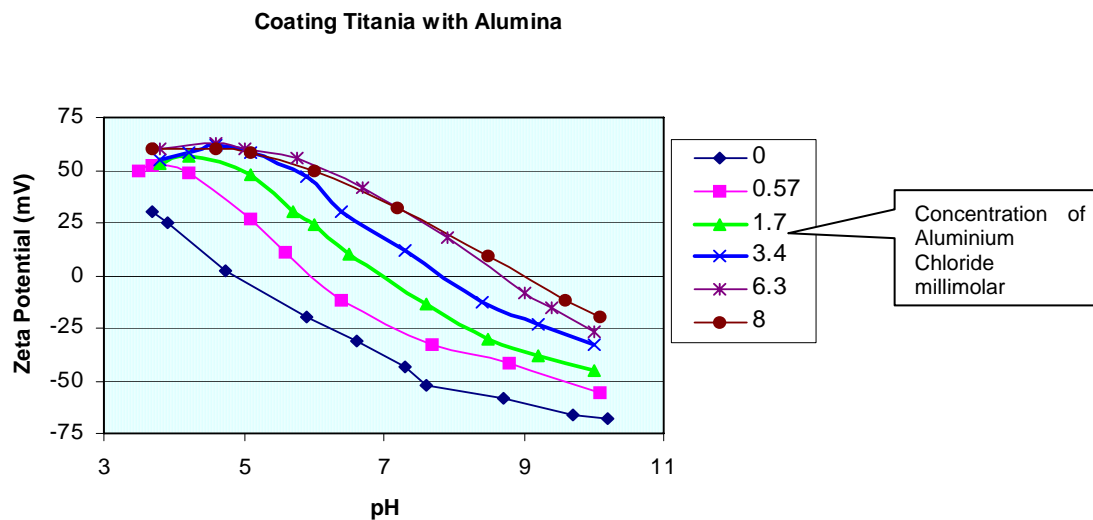
## 3 Following a coating process

In the figure 2 the titration curve is the same as for a pure silica particle. Clearly in this case the coating is thick enough to completely mask the underlying titania. How thick does the coating have to be for complete coverage, and what happens with thinner layers?

An answer to the second question is provided by the data in the figure below. In this case the AcoustoSizerII was used to follow the deposition of an alumina coating on titania particles. In this experiment, progressively larger quantities of aluminium (as

aluminium chloride or nitrate) were added to the titania sol. After each addition (at low pH) the pH was raised, causing the  $\text{Al}^{3+}$  ion to hydrolyse and becomes adsorbed on the particle surface as the oxide or hydroxide. The initial titania was uncoated and had its natural i.e.p. at about pH 5. When coating was complete the i.e.p had shifted up to pH 9.1, a value characteristic of the alumina covered surface.

Djedjev et al have recently carried out a detailed study of silica coating on titania using a combination of AcoustoSizer, dielectric response and TEM measurements of the coating layer [1]. They found that the iep drops to the limiting silica value when the coating is just under one nm thick. Further increases in the coating layer do not alter the titration curve any more. From the dielectric measurements they were able to determine that the dielectric constant of the coating is around 20, higher than the value for pure silica. The authors take this to be an indication of hydrolysis within the silica layer.



#### Reference

1. Djedjev, A. M., J. K. Beattie, O'Brien, R.W. 2005 "Coating of Silica on Titania Pigment Particles Examined by Electroacoustics and Dielectric Response." *Chemistry of Materials* **17 (15)** 3844-9. 2005