What are good surfactants for nano titania and tin oxide?

Let's assume that by nano-particles you mean particles less than 100 nm in diameter. For particles this small, especially those with high Hamaker constants like titania and tin oxide, electrostatic charge will not be sufficient. Therefore we will need to use polymers to provide a steric barrier. (This is not to say that the particles won't have some zeta potential; it is just that the electrostatic repulsion will not be sufficient.)

The Hamaker constants for titania and tin oxide are not vastly different so that the necessary steric thicknesses will be about the same. In the class we used the relation:

$$t = \frac{A_{121} d}{48 kT} \qquad [1]$$

and gave the estimate (for titania dispersions in water) that

$$\frac{A_{121}}{48 kT} = 0.70 \qquad [2]$$

so that

$$t \simeq 0.70 d \qquad [3]$$

If we use the approximation that the relation between molecular weight and thickness of adsorbed layer is:

$$t \approx \left\langle r^2 \right\rangle^{1/2} \approx 0.06\ MW^{1/2} \qquad [4]$$

We have:

$$MW \approx 100 d^2 \qquad [5]$$

where the particle diameter is in nanometers. For example, 30 nm diameter particles require a molecular weight of about 90,000.

The next question is what the chemistry of the polymer should be. The first place I like to look is in Nelson's book.[1] The next is a quick Google search; "Dispersants for titania" gave:

Farrokhpay, Saeed, PhD Thesis, 2004, University of South Australia, Ian Wark Research Institute, *Interaction of polymeric dispersants with Titania pigment particles*.

From the Materials Science Department at Ohio State University[2], *Electrosteric dispersants used in colloid processing of ceramics*, Shqau, K. which also included the reference: Greenwood, R.; Kendall, Selection of suitable dispersant for aqueous suspensions of zirconia and titania powders using acoustophoresis. *J. Euro. Ceramics Socs., 19, 479*, **1999**.

This means that there is a large literature in the ceramics field for both titania and tin oxide. And, of course, many relevant patents.

A check of the point of zero charge for these two materials[3] show them both to be about the same and acidic in water. Since they are oxides, they will have both acidic and basic character in organic solvents. They certainly adsorb materials strongly so that the key to picking good dispersants will be finding the stabilizing moieties to be as soluble as possible in the dispersion medium. That, coupled with the need for quite a high molecular weight should help is sorting through the dispersants suggested in various lists.

It is quite common to screen dispersants for these oxides by measuring the viscosities of dispersions. I do not like to use sedimentation since it seems too often to be ambiguous. The major challenge will be making well dispersed samples for the rheological test.

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[1] Nelson, R.D., Jr. *Dispersing powders in liquids*; Elsevier: New York; 1988.

[2] http://www.matsceng.ohio-state.edu/ims/KSLR.pdf

[3] Morrison and Ross, p. 318.

Measuring particle size will be necessary. The good news is that the particle size of titania is frequently measured so that literature (and commercial) help is available.