Sandia National Laboratories

Low Cost TiO_2 Nanoparticles

POTENTIAL MARKET APPLICATIONS

Solar Cells
Improved cell open-circuit voltage over anatase cells

Catalysis/Photocatalysis
Higher catalytic activity than rutile and anatase phases

Rechargeable Batteries
More stable upon cycling than anatase and rutile Li batteries

Optical Devices
High refractive index; only natural TiO_2 with biaxial optical properties

BENEFITS

Cost Effective
Utilizes readily available, low cost, surfactants and solvents

Easy Scale-up
Process can be easily introduced to large scale industrial applications

Fast
Can be produced within hours

Predictable
Small size distribution (2-8 nm) without agglomeration

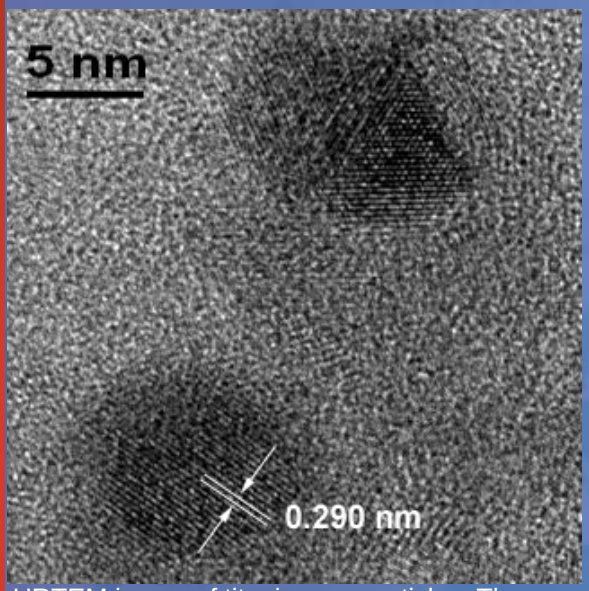
INTELLECTUAL PROPERTY

US PATENT #7,934,116

SD# 10638

TECHNOLOGY SUMMARY

Traditionally, preparing brookite TiO_2 nanoparticles has required extremely expensive surfactants and/or high temperature processing. Even processing under these conditions often only resulted in nanoparticles with extremely wide particle size distributions and significant particle agglomeration. Brookite, which differs from both the rutile and anatase phases in that it has an orthorhombic crystal structure and lower symmetry, has significant potential in numerous energy markets. Brookite's structure allows for only minor effects on charge carriers, making it a good candidate for photovoltaic devices. Brookite particles also offer significant promise in solar cells, catalysis, as a possible electrode material in rechargeable lithium batteries, and in many optical devices due its large refractive index and oxidation potential. The ability to controllably and predictably produce brookite nanoparticles has been an area of significant research.



HRTEM image of titania nanoparticles. The particles are polycrystalline and lattice spacing from the [121] axis of brookite titania can be seen in the lower particle.

Sandia has developed a novel method to produce brookite TiO_2 using a solution of varying ratios of titanium isopropoxide and isopropanol mixed at a sufficiently slow rate so as to yield nanoparticles with a small size distribution (2-8 nanometers) and without any particle agglomeration. This technology uses cost effective, widely available surfactants and solvents, and can be easily scaled up to industrial level.

TECHNOLOGY READINESS LEVEL

Sandia estimates this technology at approximately TRL 4. Key elements have been demonstrated in the laboratory environment.

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National Nuclear Security Administration

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SAND # 2011-7918P