Tin Oxides

SUPERLITE | THERMOX

AMC
Member of the AMC Group

Keeling & Walker
World Leader in Tin Oxide

OUR ORIGINAL
PREMISES FROM 1916

Based in Stoke-on-Trent, the heartland of the British ceramics industry, Keeling & Walker was incorporated in 1916 as a supplier to the local potteries.

The company quickly realised the importance of tin oxides as a key raw material for colour pigment production, and by the 1930s had established a unique manufacturing process which has set the industry standard to the present day.

In the late 1990s Keeling & Walker acquired the THERMOX tin oxide business from Th. Goldschmidt AG in Germany, making it the largest tin oxide manufacturer in the world. In 2015 the company established a new manufacturing site to expand its production capabilities still further.

Continuous investment in R&D has allowed Keeling & Walker to diversify its output and develop into an advanced materials company with a unique range of products. Its ISO 9001, 14001 and 50001 compliant facilities produce innovative, high quality products which cater to the demands of a wide range of industries.

Today, Keeling & Walker's SUPERLITE brand is the most recognised on the market.

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PRODUCT RANGE

Tin Oxide is a white, inert and chemically very stable material. The reaction of Tin Oxide with other metal oxides is the basis for many colour pigments, which are widely used in the ceramics industry.

Tin Oxide is typically synthesized from metallic tin either by thermal oxidation in a gas phase process or by a wet chemical precipitation process.

Keeling & Walker is using both basic processes and numerous further processes to manufacture a range of Tin Oxides to cover the requirements of the different technical applications. Keeling & Walker offers the broadest range of Tin Oxides in the world market.

Responsible sourcing the required amounts of tin metal for the production is an important issue for Keeling & Walker. All tin metal is certified as conflict free material and originate from reliable smelters. The tin metal sources are geographically spread over three continents to minimize supply chain risks.

Even in difficult times Keeling & Walker´s supply chain has been proven reliable ensuring that Keeling & Walker is always able to supply its customers.

SUPERLITE

Quality is all-important in ceramic colour pigment manufacturing. Ensuring the quality of raw materials and rigorous analytical control of their chemical and physical properties is the key to producing high performance colour pigments.

Uniform particle size distribution significantly improves the performance of opacifiers and polishing agents.

Keeling & Walker's SUPERLITE tin oxides are available in a variety of grades, bulk densities and purities. We use high grade tin metal as feedstock for production, so meeting special trace element requirements is no problem.

SUPERLITE grades are used in:

- Ceramics as an opacifier and colour pigment raw material
- Glass as a refining additive
- Abrasives as a polishing agent
- Electroceramics and surge arrestors

Product	Bulk density (g/l)*	BET surface area (m^2/g)*	Particle size D50 (µm)	Remark
SUPERLITE	600	7 - 9	0,8	Most versatile grade
SUPERLITE A	1100	7 - 8	0,8	High bulk density
SUPERLITE C	600	7 - 9	0,8	Pb < 100 ppm
SPG	700	8	0,8	Cost effective material
SV5	1500	3	1,4	Free flowing material
Vertex	1000	6	0,9	
PFO150	1350	1	Approx. 75	Coarsest grade

SPECIALITY OXIDES

Keeling & Walker is the world leader in tailoring the properties of tin oxides to individual applications.

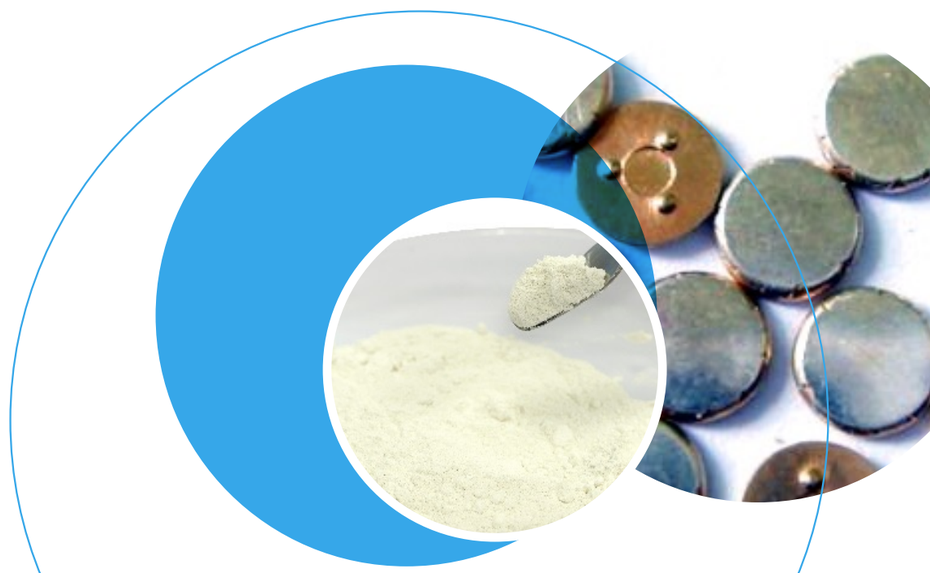
High bulk density tin oxides with a BET surface area as as low as 0,2 m^2/g are perfectly suited to the application of electrical contact materials.

They generate long term stable contacts which show a low rate of disintegration over their lifetime. Keeling & Walker's range of CS tin oxide grades is the most advanced in the world. Our products have achieved a superior market position for high quality electrical contact materials due to their unique properties.

Keeling & Walker also produces tin oxides doped or coated with other metal oxides such as indium, bismuth or copper oxide which are available on request.

Tin Oxides with an optimized particle size distribution find great interest in the glass industry, especially for manufacturing of Display glass and for glass melting electrodes.

Product	Bulk density (g/l)*	Tap density (g/l)	BET surface area (m^2/g)*	Particle size D50 (µm)
CS1	550	800	1,3	1,5
CS1-L	550	800	2	1,2
CS3	750	1500	0,6	2,8
CVS4	1000	2000	0,3	4,0
CVS6	1000	2000	0,2	6,0
CSC/DW	800	1600	0,6	2,8
CSM/DW	700	1450	1,1	1,8
CSF2/DW	750	1500	1,3	1,5



* Approximate value

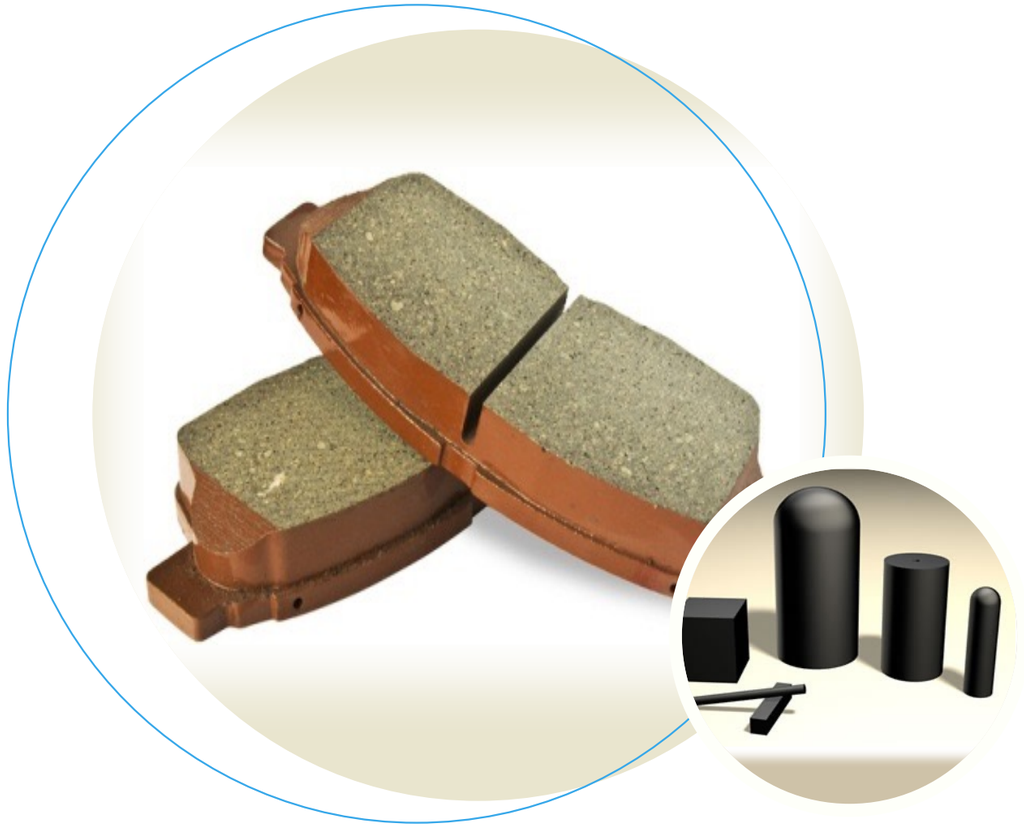
THERMOX TIN OXIDES

Keeling & Walker manufactures a unique range of tin oxides using the THERMOX process.

SUPERLITE tin oxides generally have a spherical particle shape. THERMOX products have a more irregular particle shape and perform differently as a result. THERMOX RL is the finest tin oxide grade available. With a D50 of 0,2 µm it is highly advantageous for colour pigment manufacturing.

The sintering properties of THERMOX grades is superior to SUPERLITE. It benefits industries that work with glass melting electrodes, friction materials, abrasive or electrical contact materials. The THERMOX process is flexible and can produce oxides with a wide variety of purities.

Product	Bulk density (g/l)*	Tap density (g/l)	BET surface area (m^2/g)*	Particle size D50 (µm)
RL	300	600	11	0,2
EFGE	500	1000	7	0,4
VN	650	1300	5	0,5
VS	850	1700	4	0,7
R39	900	1800	3,5	0,75



STANNIC ACIDS

Stannic acids are a hydrated form of tin oxide matching the general formula SnO_2 x H_2O. Depending on their properties they are also referred to as Alpha- or Metastannic Acids.

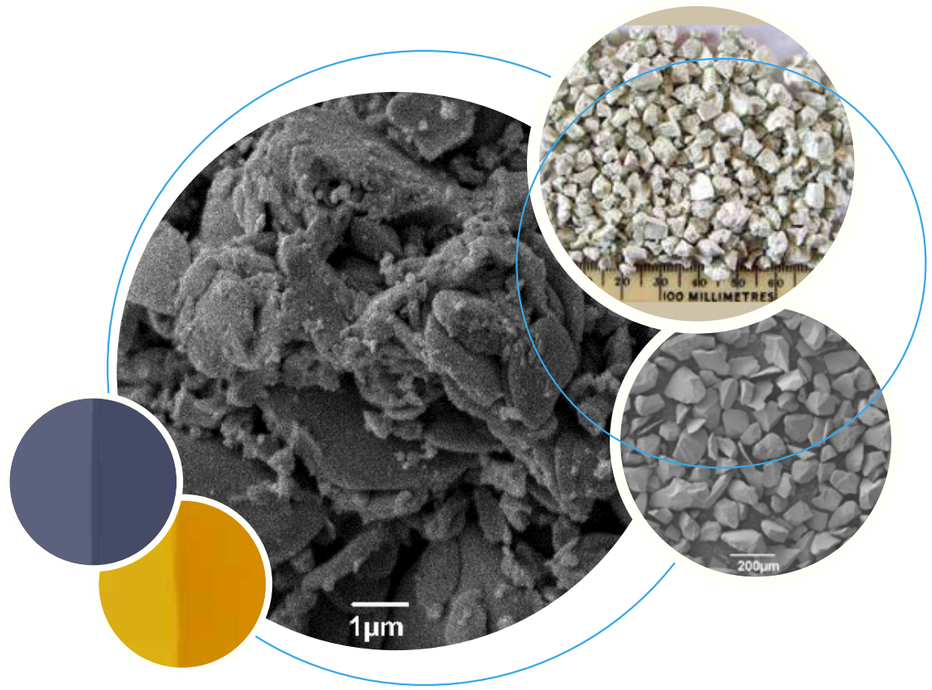
The process provides tin oxide particles with a high degree of hydroxyl groups – the key to the product's remarkable reactivity – on their surface. Further modification allows us to create tin oxides with tailored surface areas.

The higher reactivity of metastannic acids compared to tin oxides made via the thermal route opens the pathway to a number of applications. Intense colour shades can be achieved in ceramic colour pigments and it is also possible to reduce firing cycles.

Doping the porous structure of metastannic acid with precious metals creates sensor materials suitable for the detection of gases used for environmental and air quality control. Similar processes with other metal oxides generate catalysts for petrochemical processes.

For radiochemical applications high purity alphastannic acid (HPASA) offers high ion-exchange capacity for specific radionuclides.

Product	BET surface area (m^2/g)*	Particle size D50 (µm)	Bulk density (g/l)*	pH (50% w/w aqueous slurry)*	Loss on ignition (@1000°C in %)
MSA	> 160	10	1600	0,5 - 2,0	9
HSATO	35 - 45	15	1700	3	1
HPASA	> 160	100	1800	2,5	11 - 15



* Approximate value

HIGH PURITY TIN OXIDES

High tech applications can often only be realised if raw materials with unique properties or high purity levels are available.

Ultrathin metal or oxide layers used in the electronics and semiconductor industries are made using different evaporation or sputtering methods. High purity raw materials are integral to these processes, enabling the formation of defect free thin films with the required electrical or optical properties.

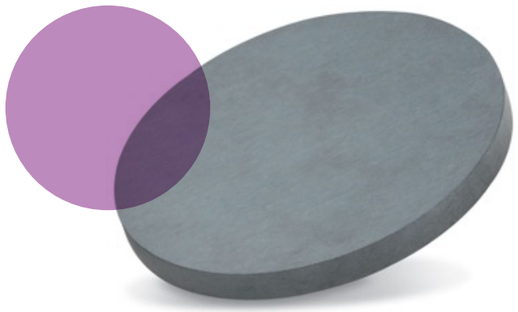
Keeling & Walker has developed a range of high purity tin oxides based on chemical and thermal oxidation processes which match the stringent quality requirements of our target manufacturers. Our unique manufacturing technology generates homogeneous ultra-fine particles with a tailored BET surface area to improve sintering properties. Purity levels can be varied between 99.95 and 99.995%. Rigorous in-house quality control and purity analysis ensures homogeneity down to the individual trace element.

Product	Purity	Bulk density (g/l)*	Tap density (g/l)	LOI (%)	BET surface area (m^2/g)*	Particle size D50 (µm)
HPTO	99.99%	1400	2200	< 5	4 - 6	2 - 5
RL-HP	99,995%	300	600	< 3	11 - 17	0,2
RL-IV	99.99%	300	600	< 3	11 - 17	0,2
TL-HP	99,995%	350	700	< 3	8 -9	0,3-0,4

STANDARD TRACE ELEMENT DISTRIBUTION FOR 99,99% PURITY TIN OXIDE

Element	Specification
Sb, Mg	30 ppm maximum
Fe, Si, Ca	20 ppm maximum
Ag, As, Al, Bi, Co, Cr, Cu, In, Mn, Na, Ni, Pb, Zn	10 ppm maximum
Cd, Hg	5 ppm maximum

Total of all impurities listed above	100 ppm maximum
Purity (as SnO_2)	99.99% minimum



NANODISPERSIONS

Keeling & Walker offers a range of nanosized colloidal tin oxide dispersions which are tailor-made for aqueous coatings on glass, ceramic or polymeric substrates.

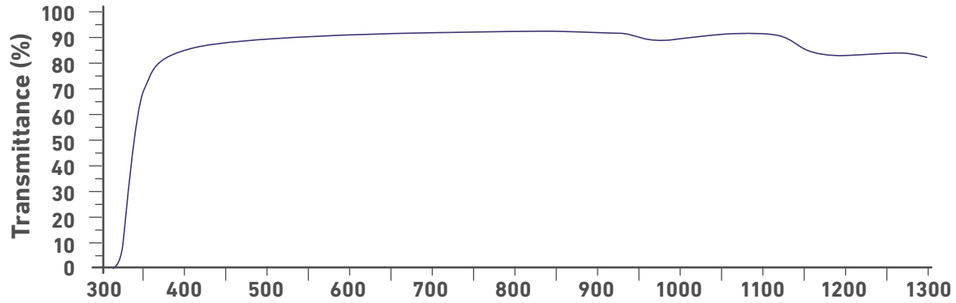
Highly transparent coatings are achievable due to the nanosized particles. The dispersions show great stability with no settling even over a prolonged storage time due to their strong electrostatic stabilisation.

Tin oxide nanodispersions are used for highly specific applications. They can be used to deposit sensor materials for the control of air quality or to formulate antireflective or high refractive index coatings. Other application areas include solar cells, flame retardants, anticorrosion coatings and catalysts.

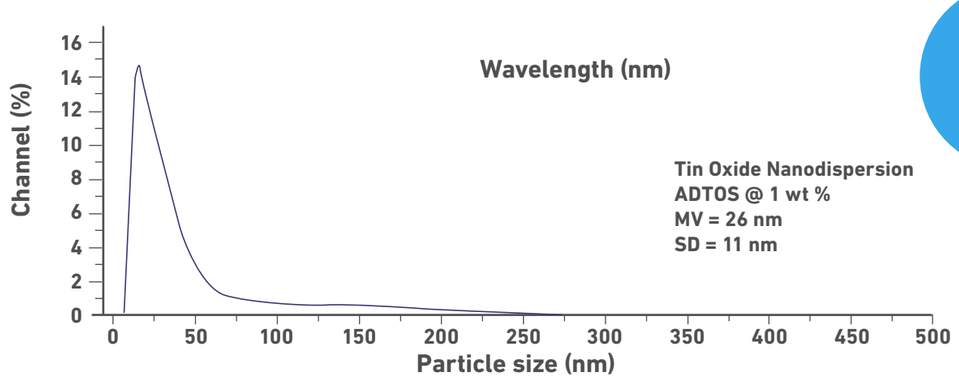
Tin oxide nanodispersions are also suitable raw materials for the synthesis of doped tin oxides.

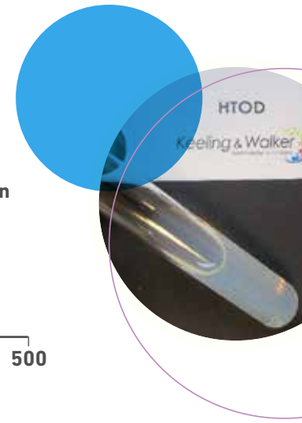
Product	Stabilizer	Solids content (%)	Specific gravity (g/cm^3)	pH
HTOD	KOH	27 - 30	1,3 - 1,4	10 - 14
ADTOS	NH_3*H_2O	10	1,1	10 - 12
AMSOL	Aminoalcohol	17 - 21	1,1 - 1,2	10 - 12
Dispersion DQ	Dispersant	25	1,2	7

Transmission spectrum of HTOD in the visible and near infrared spectral range



Particle Size Distribution of ADTOS





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PRODUCT SELECTOR

Keeling & Walker's product selector shows the most suitable tin oxide grades for specific applications:

	Ceramic colours	Glazes /Opacifier	Electroceramics/ Surge arrestors	Glass refining additive	Glass melting electrodes	Friction materials/ polishing	Electrical contact materials	Cosmetic/medical applications	Catalysts	Sensor materials	Sputtering targets	Transparent coatings	Ion exchange material	Battery material	Metal alloys/welding	Polymer additive
Superlite / A/C	■	■	■	■		■		■							■	■
SPG	■															
SV5	■														■	■
PFO150						■					■					
CS1 / CS1-L				■	■											
CS3						■	■									
CVS4				■	■		■									
CVS6				■			■									
CSC/DW							■									
CSM/DW							■									
CSF2/DW							■									
RL	■								■					■		■
EFGE	■	■		■												
VN	■		■			■		■								
VS	■		■		■		■									
R39	■	■														
RL-HP / TL-HP									■		■			■		
RL-IV											■			■		
Metastannic acid	■								■	■			■			■
HPASA								■					■			
HSATO									■	■				■		
HPTO				■				■	■	■	■					
HTOD						■						■				
AMSOL						■			■	■		■				
ADTOS						■				■		■				

REGULATORY STATUS OF TIN OXIDE

Country	Question	Yes	No	Comments
USA	Listed in TSCA inventory	✔		ID 20926
	TSCA confidential section		✔	
	Reported as new substance		✔	
	Components subject to restriction (e.g. Test Rule, Consent Order, SNUR, Export Notification)		✔	
	California Proposition 65		✔	
Canada	Listed in DSL	✔		
	Listed in NDSL		✔	
	Reported as new substance		✔	
Japan	Listed in MITI / ENCS	✔		MITI number 1-551
	Reported as new substance		✔	
Australia	Listed in AICS	✔		
	Reported as new substance		✔	
New Zealand	Listed in NZIOC	✔		HSNO Approval Code HSR002805
	Reported as new substance		✔	
EU (EEA)	Registered according to REACH	✔		Registration Number 01-2119946062-44-XXXX
	Reported as new substance		✔	
	RoHS compliant	✔		
UK REACH	Registered according to UK REACH	✔		EU REACH registration grandfathered to UK REACH Registration Number UK-01-3016796871-5-0002
TURKEY REACH	Registered according to TURKEY REACH		✔	Registration due in 2023
Switzerland	Listed in EINECS	✔		
	Reported as new substance		✔	
Korea	Listed in KECI	✔		KE No.: KE-33849
	Reported as new substance		✔	
Taiwan	Listed in TCSI	✔		
	Reported as new substance		✔	
Republic of the Philippines	Listed in PICCS	✔		
	Reported as new substance		✔	
PR China	Listed in IECSC Inventory	✔		
	Reported as new substance		✔	

Keeling & Walker supplies its products in accordance with all national and international regulations. Keeling & Walker manufactures with 'conflict free' raw materials. Our tin oxide grades contain no substances at a concentration greater than that permitted within the Restriction of the Use of Certain Hazardous Substances (RoHS) in Electrical and Electronic Equipment (EEE) Directive (2011/65/EU).

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