Use of waste minerals as functional fillers

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What is a functional filler?

- What can a functional filler control in a paint/polymer?

- Colour/Whiteness
- Chemical Inertness
- Opacity/Light Scattering
- Gas transfer
- Biocide release

From the mineralogy comes functionality

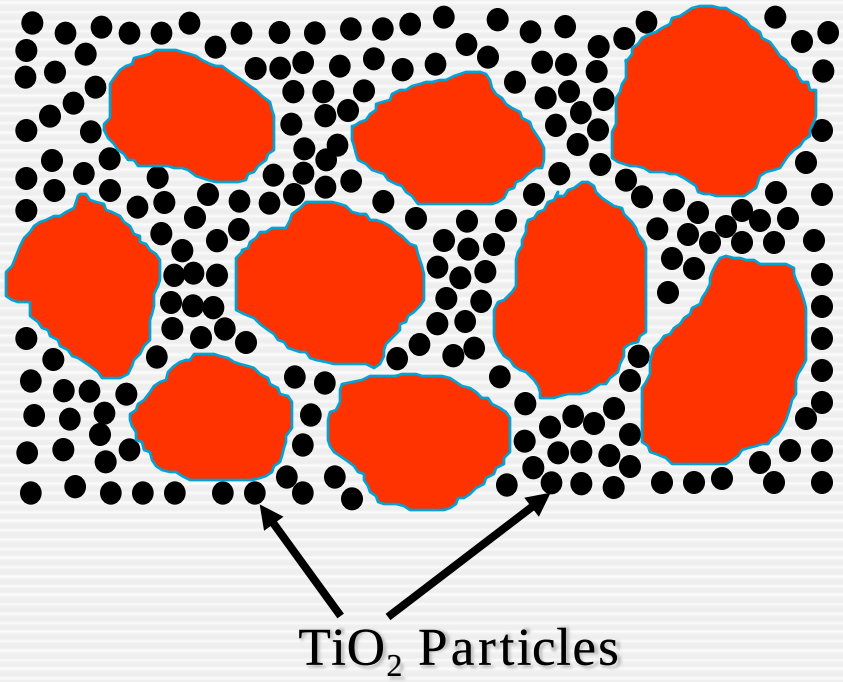
Mineral structure	Functionality
Particle size, aspect ratio	Opacity [hollowspheres]
Refractive index	Abrasion resistance
Specific gravity	Barrier properties [aspect ratio]
Hardness	Flame retardant
Colour/whiteness	Chemical delivery [organic biocide]
Surface chemistry	Mechanical reinforcement
Chemical structure	De-icing/low friction surfaces [conductive films]
Particle packing	
Conductivity	

Control packing of particles in paint by...

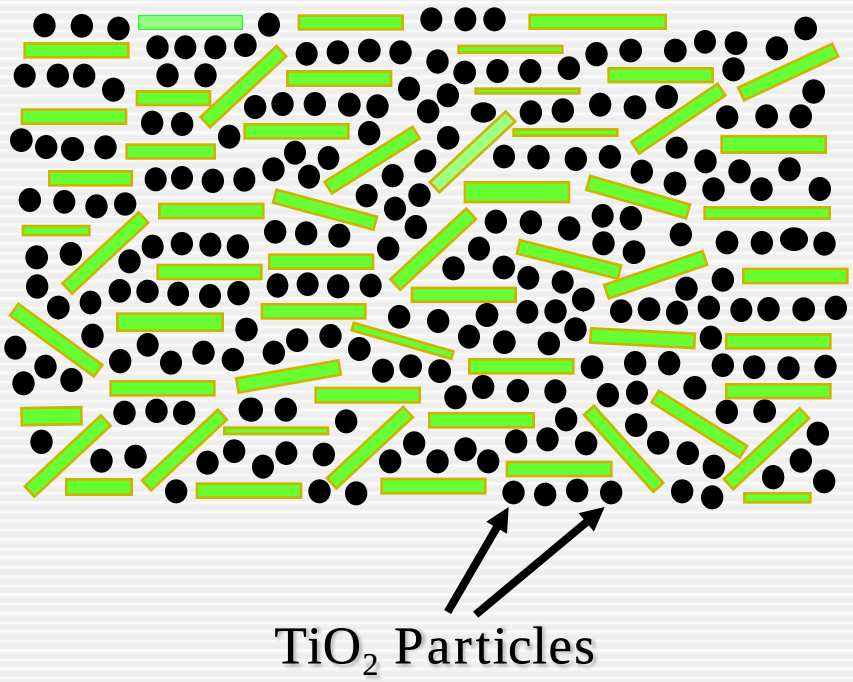
- Particle size distribution of pigment (titanium dioxide) and fillers/extenders.
- Trend towards fine particles to give better paint performance-but this is high energy option and comprises a major part of the carbon footprint of the product.
- Certain advantages in high aspect ratio minerals in some applications- mill to enhance this . Utilise fine waste from quarry operations that have high aspect ratio. [Basalt]

Particle packing: distribution of pigment

- **TiO_2 + Coarse Extender**

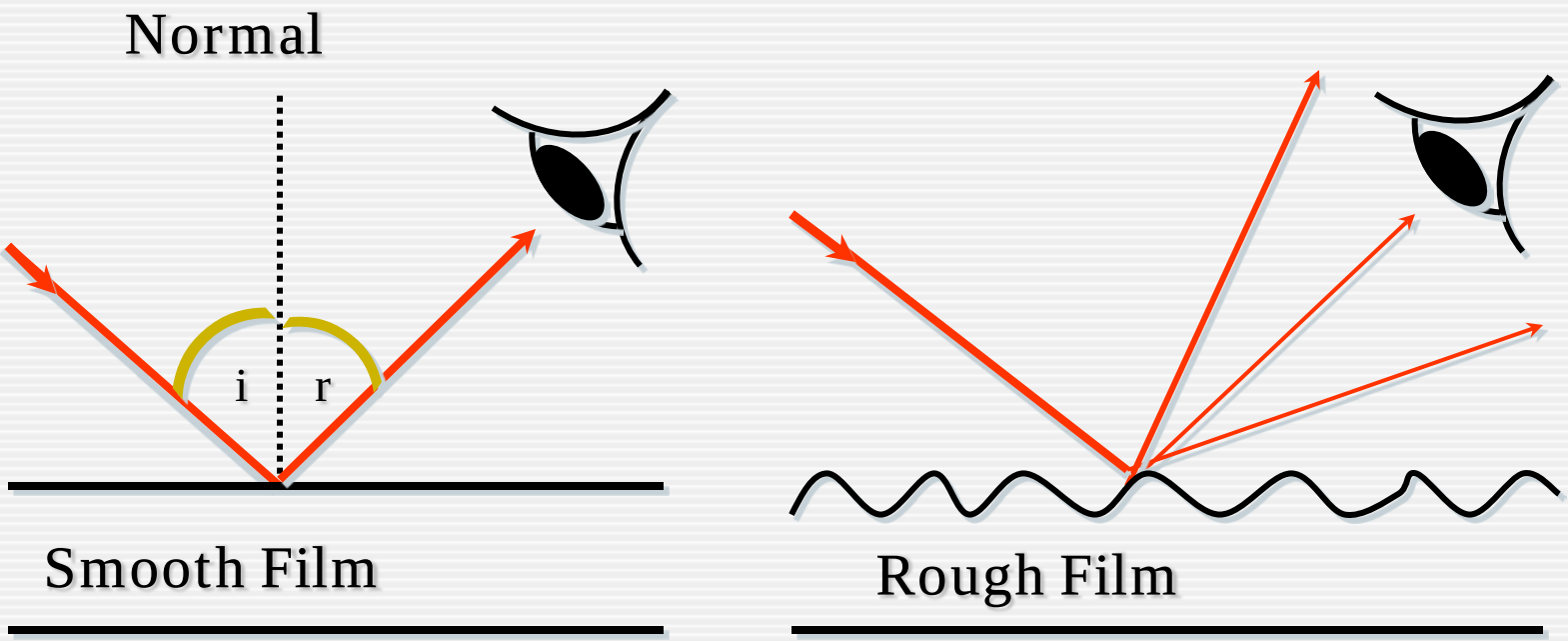


- **TiO_2 + Fine Kaolin**



Courtesy of Imerys

Effect of Surface Smoothness on Gloss



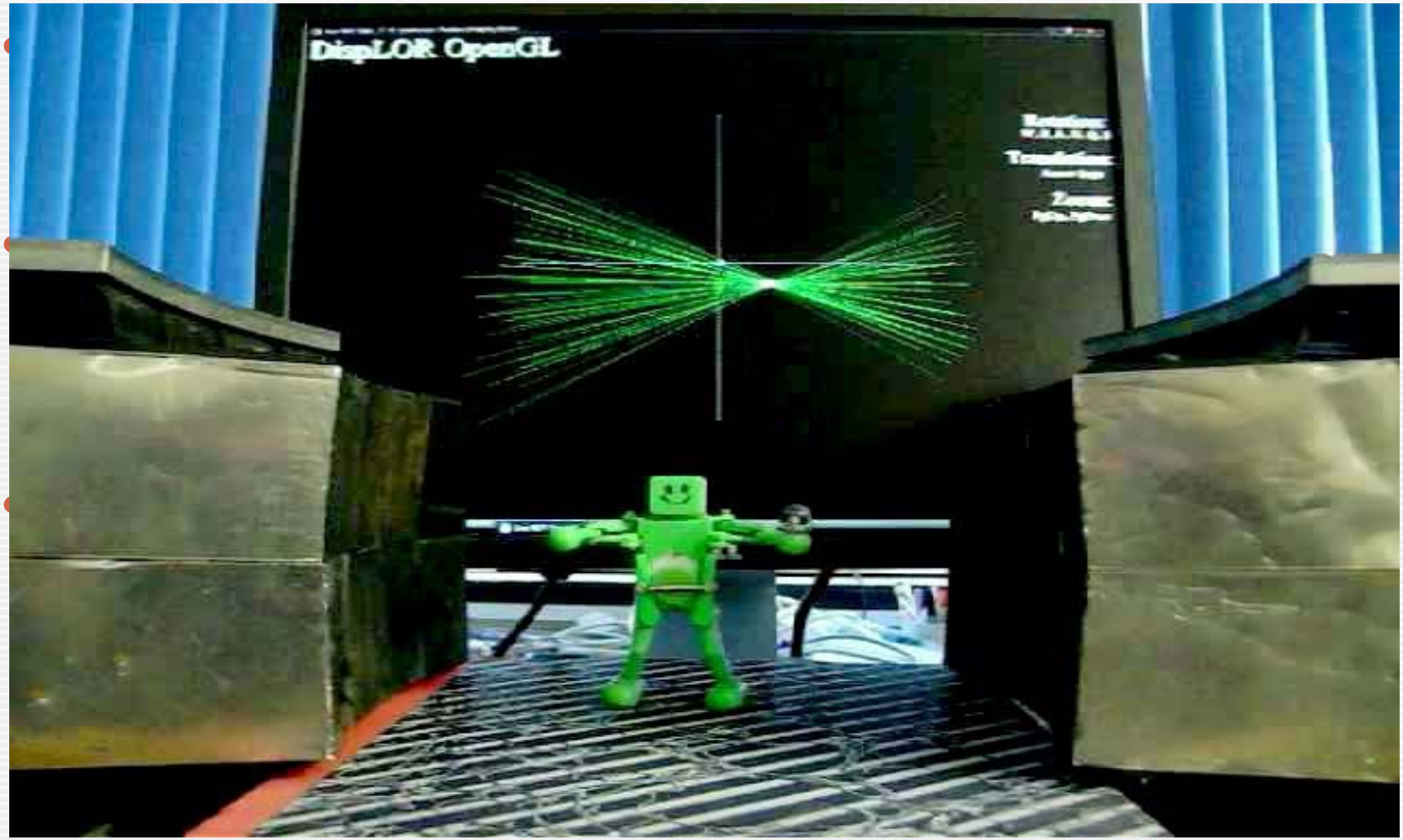
Rough paint film surfaces give low gloss

Courtesy of Imerys

Reduce energy to produce functional fillers

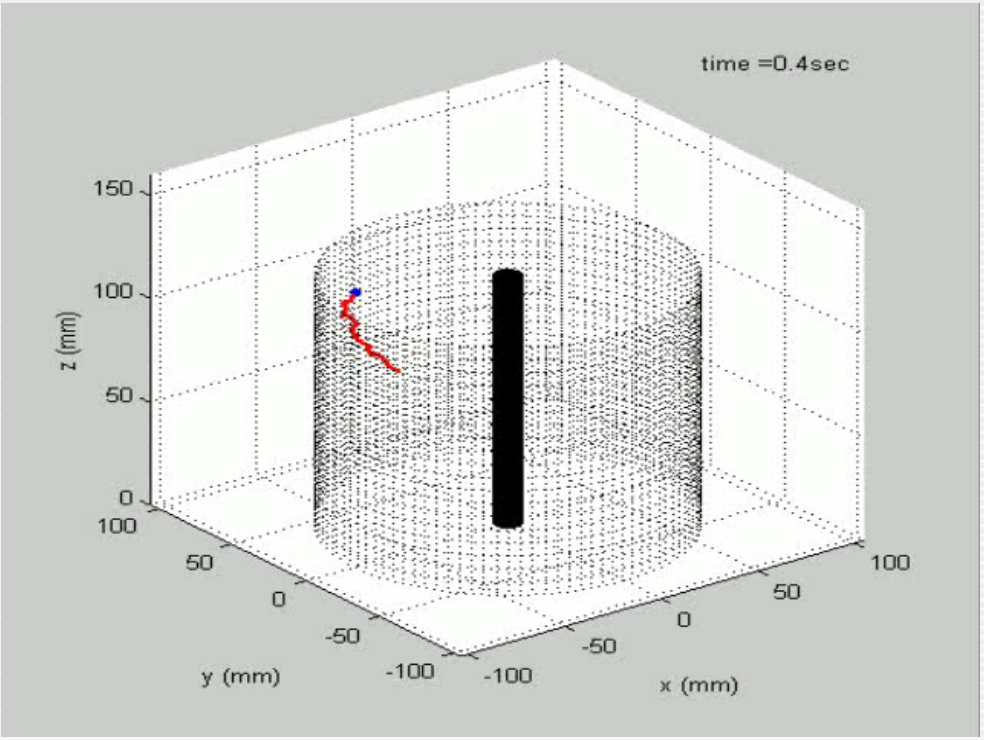
Trend for finer PSD fillers	• Optimise mill design [PEPT] • Milling circuit design optimisation [JKSimMet]
Need for low density fillers	• Use specific recycled materials [PFA-RockTron] • Formulate low density by engineering [Opacalite]
Reduce energy required for thermal treatments	• Selective microwave heating [Vermiculite]

Positron Emission Particle Tracking

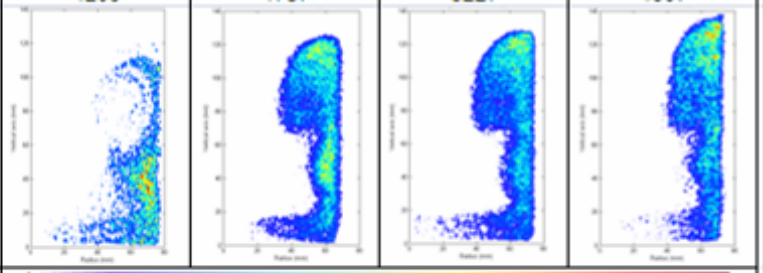
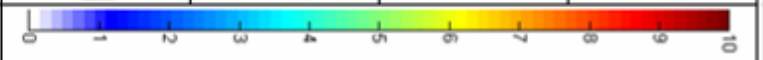
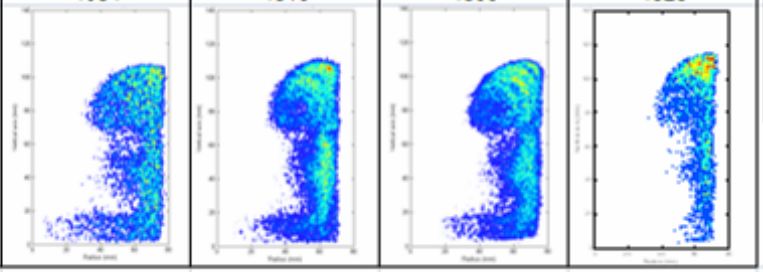


Reduce energy for fine particle production

- Stirred media mill design optimisation using positron emission particle tracking. (PEPT)
- Outcome patent for new mill media shape with Imerys.
- Outcome reduced energy consumption in kaolin/calcium carbonate mills.

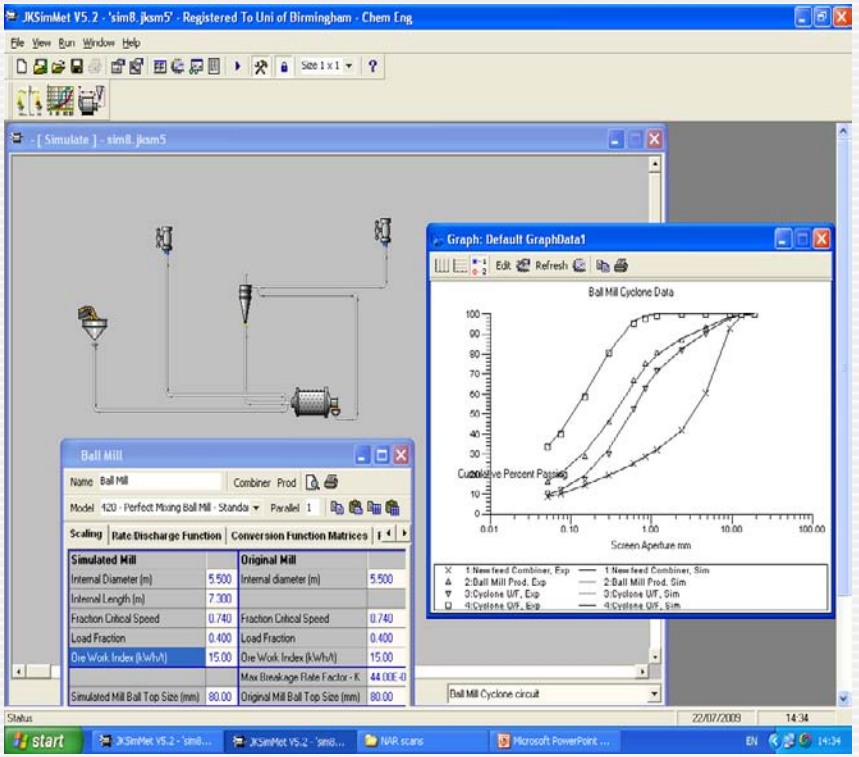


Effect of media density on efficiency of mill

	1000 rpm			
Density (g/cm^3)	2.71	3.5	4.2	6
Height (mm)	124	127.1	129.8	138.1
% time in lower region	78.8	50.0	47.1	42.4
Area (a.u.)	4209	4787	5227	4607
Image				
				
	Scale bar - Occurences/10 000)			
	600 rpm			
Density (g/cm^3)	2.71	3.5	4.2	6
Height (mm)	108.2	113.7	111.2	117.3
% time in lower region	61.7	59.6	58.8	51.7
Area (a.u.)	4084	4816	4899	4323
Image				

Process intensification of milling process

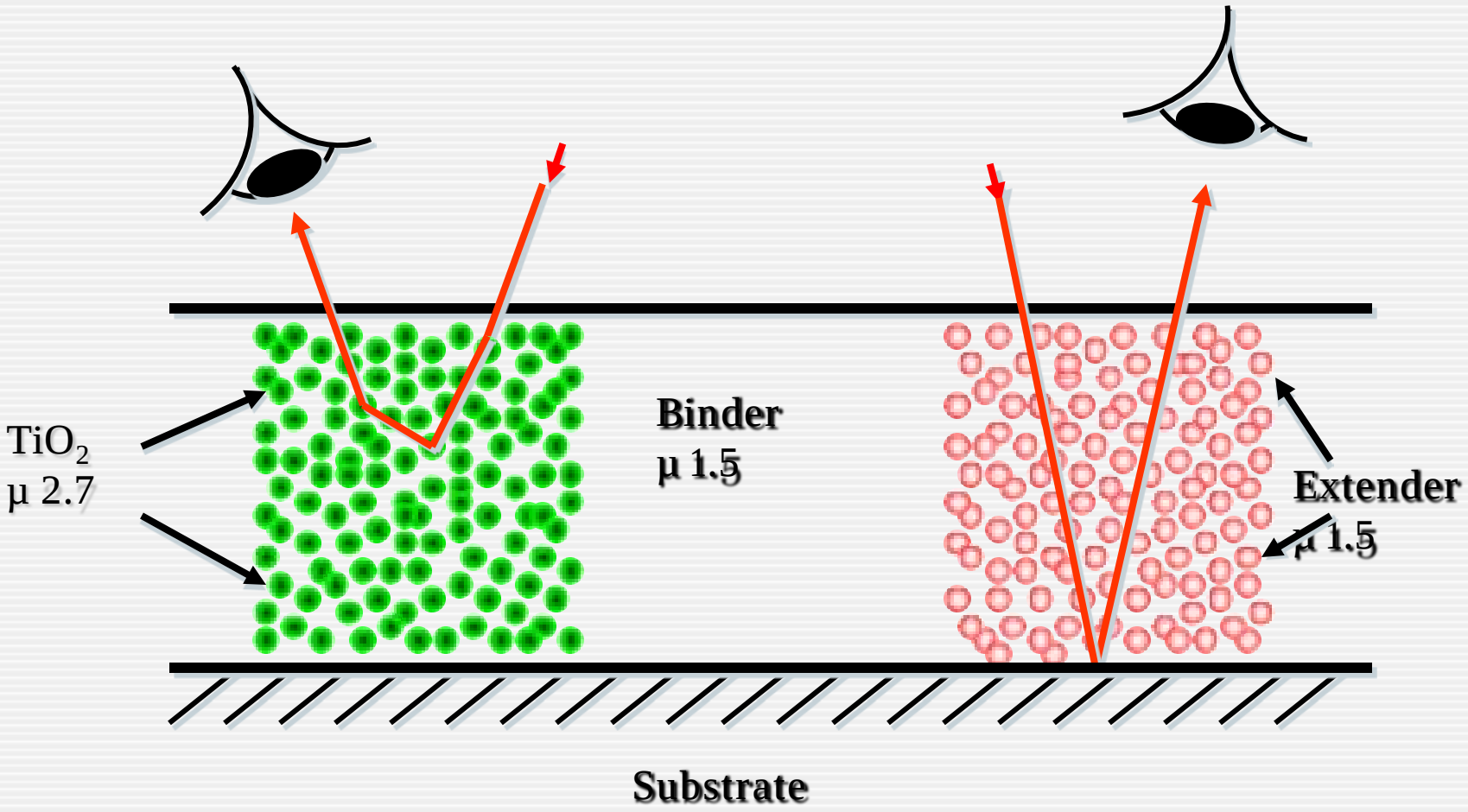
- Use of JKSimMet modelling package to optimise milling operations. [Tarmac]
- Objective to reduce energy requirement and maximise desired particle size range required.
- Reduction of “fines” generations



Engineered low carbon footprint fillers

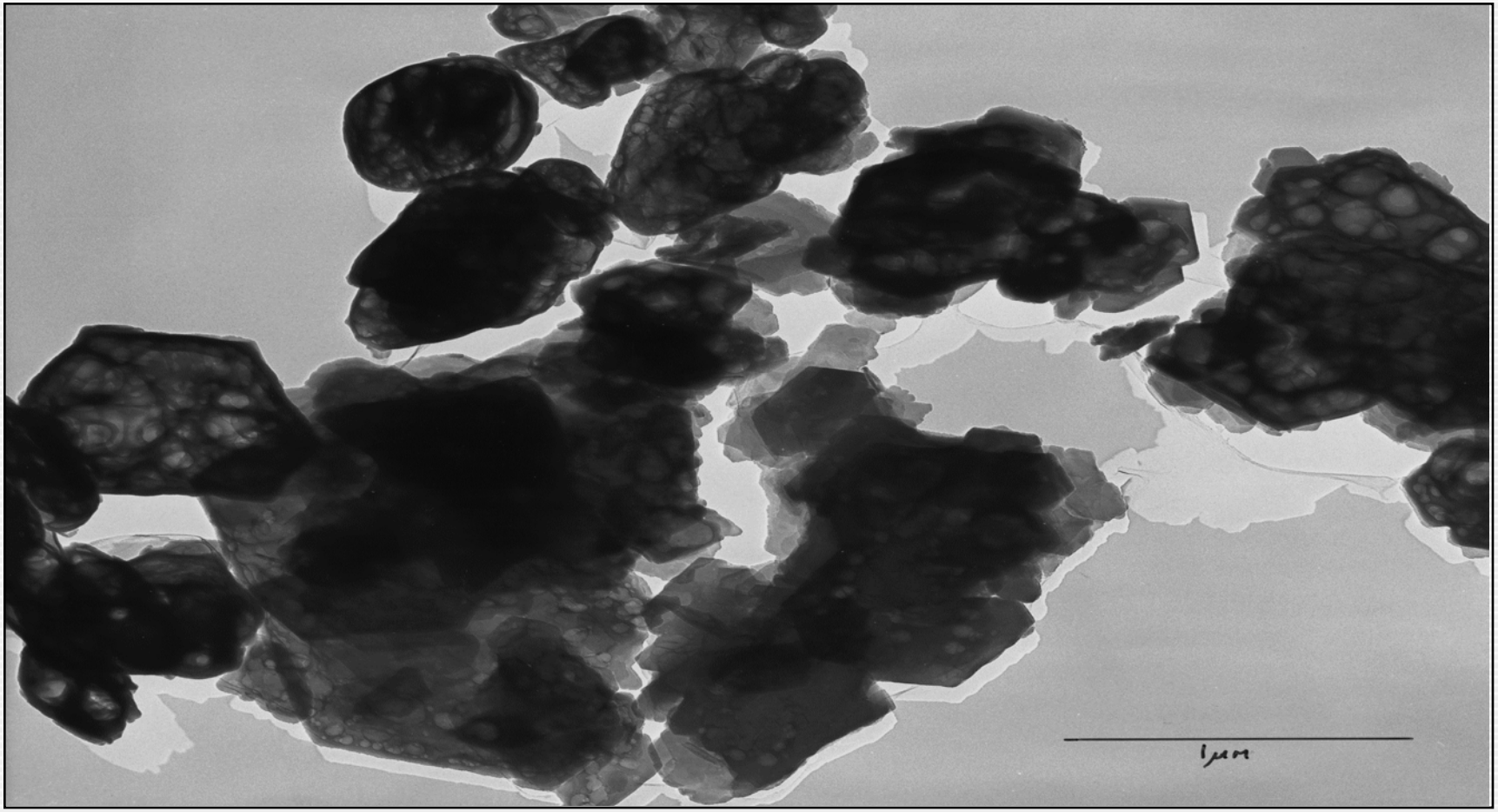
- Flash calcined kaolin as a part replacement for titanium dioxide in paint films.
- Lower carbon footprint/lower cost option compared to titanium dioxide
- Retains many of the light scattering attributes of titanium dioxide

Effect of TiO_2 and extender in a paint film



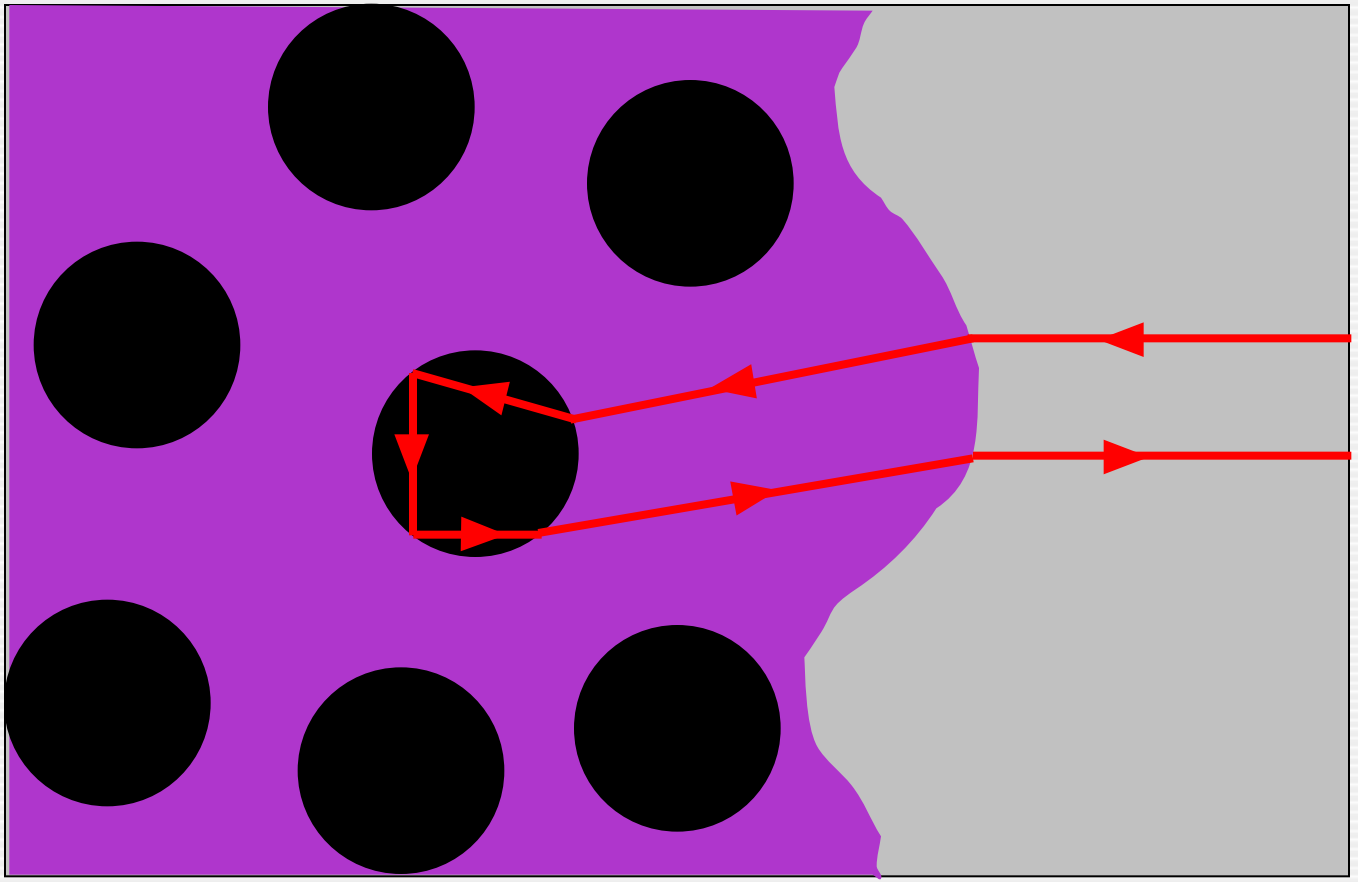
Courtesy of Imerys

Internal voids create by flash calcination



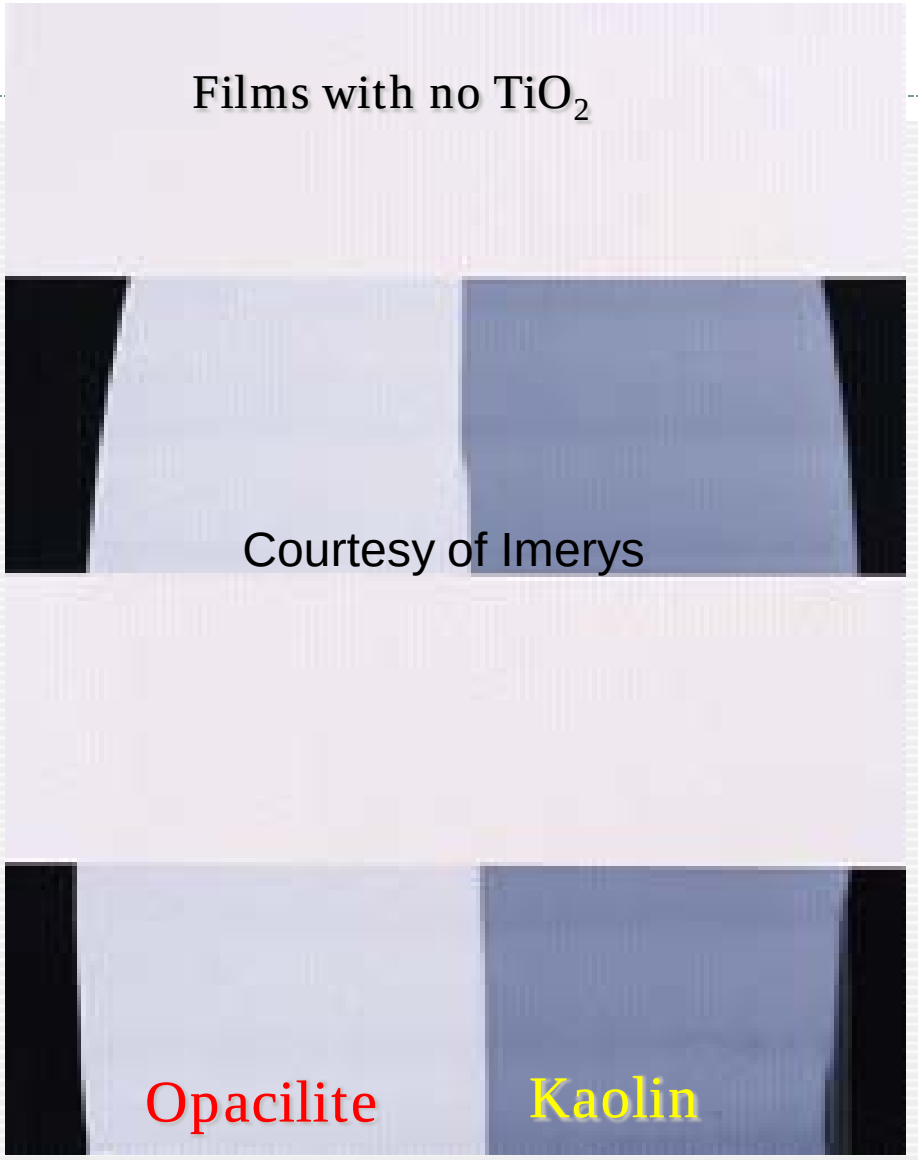
Courtesy of Imerys

Light scattering by an Opacilite



Courtesy of Imerys

Effect on Dry Film Opacity



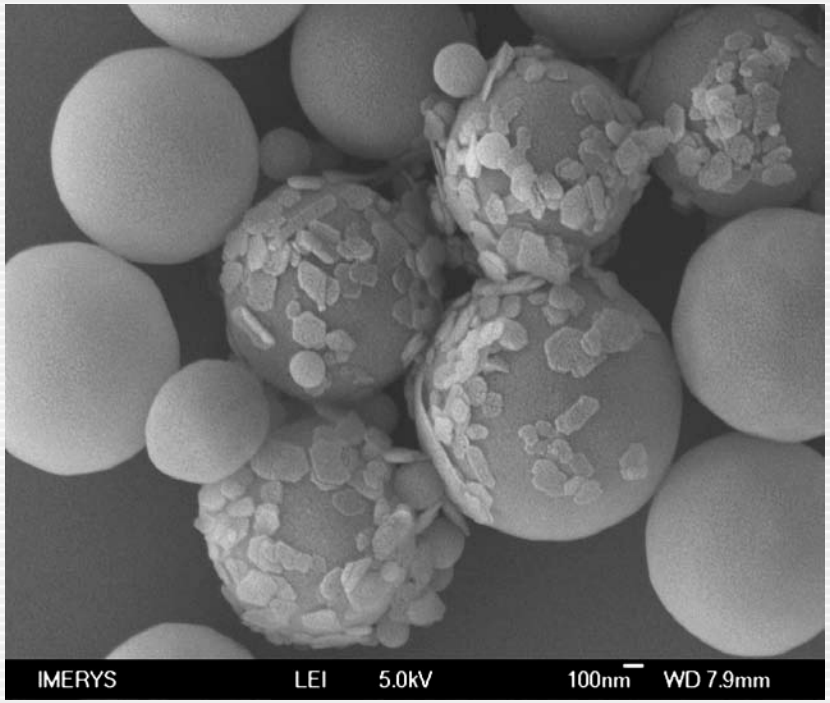
Courtesy of Imerys

Low energy expanded vermiculite

- Microwave exfoliation of vermiculite.
- Selective dielectric heating of OH bonds in layered sheets of the vermiculite requires less energy than traditional Tor-Bed type fluidised bed reactor.
- Exfoliation can take place at users facility.

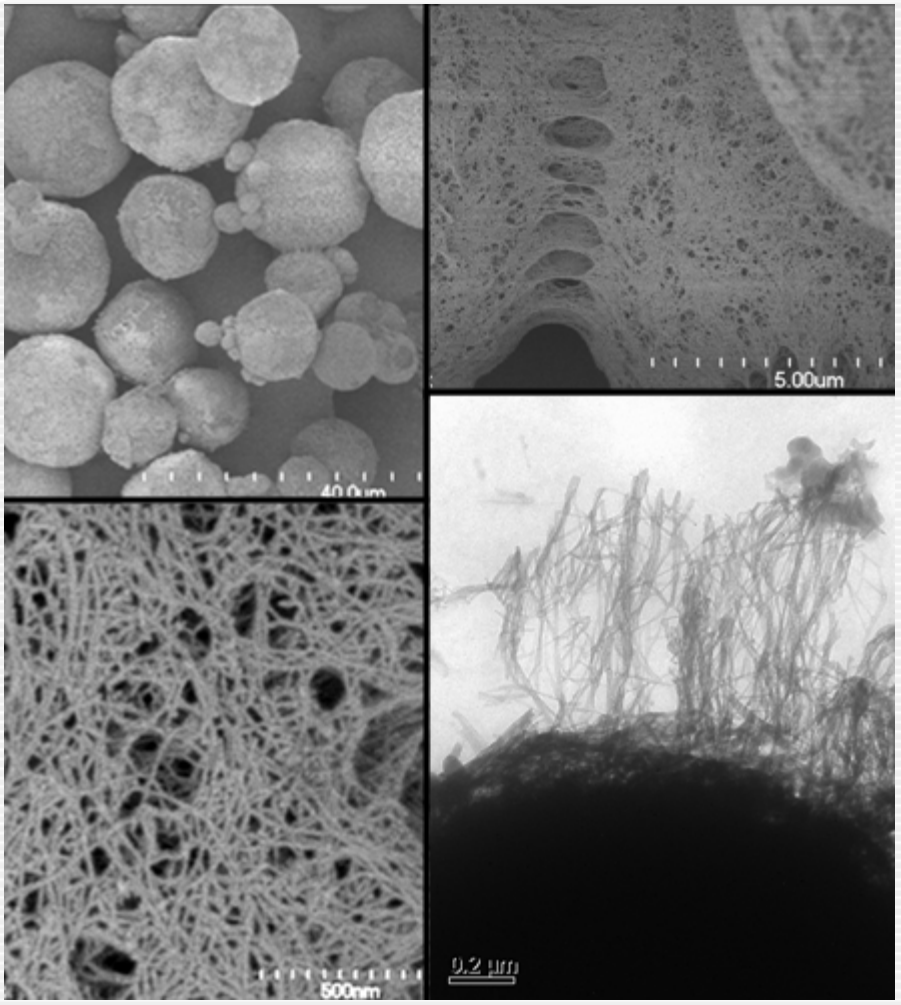
Bottom up approach to low density fillers

- Plant scale production of hollow spheres via the self assembly method [Imerys]
- Use of waste potassium chloride from potash production to formulate low density bone components



Amorphous bio minerals

- Developing methods for the precipitation of amorphous biominerals with novel structures for medical and other applications



Drivers for waste minerals as fillers

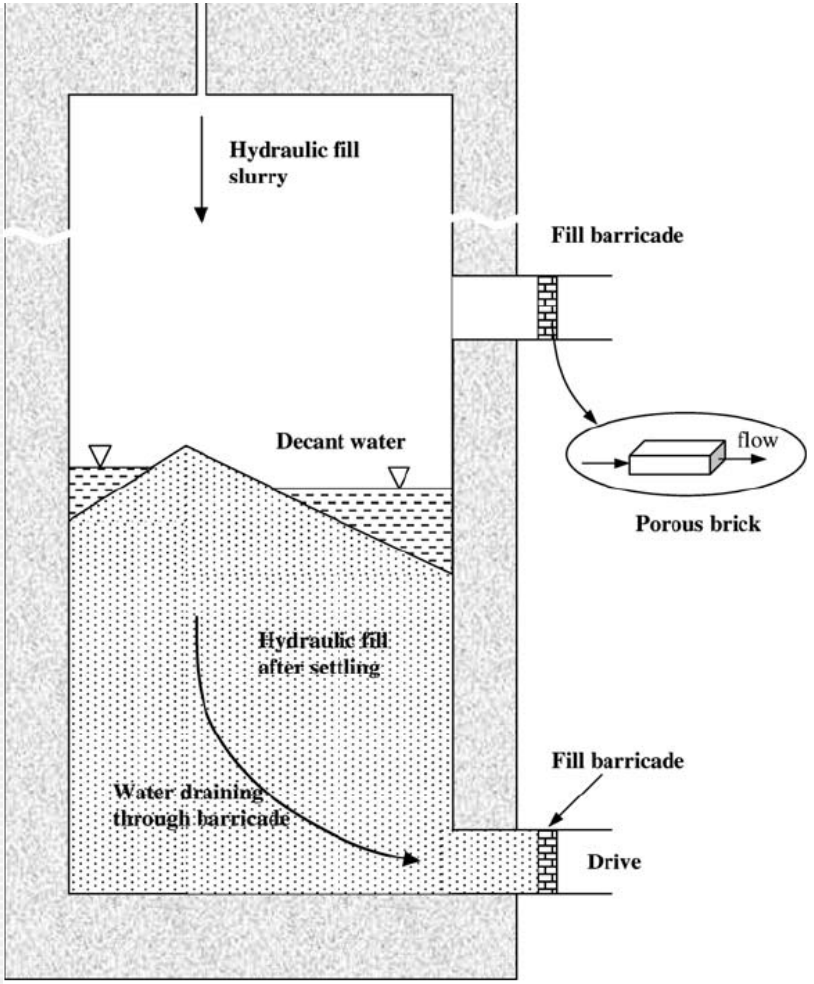
- Landfill tax- present and future costs
- End user pressure to increase recycled element of paints/polymers
- Lower carbon footprint in paint/polymer production

Large scale functional fillers!

- Problem with acid mine drainage from disused coal mines in UK.
- Problem with subsidence from mining operations.
- Traditional answer chemical precipitation plant or reed bed technology with large footprint

Use of steel waste as functional mine filler

- Use steel waste as paste backfill for disused coal mines.
- Waste has high free lime content and cation exchange capacity to capture Fe, Zn etc from AMD.
- Metals present slow setting rate of backfill hence allows good subsidence inhibition.



New project.....

Use of refractory waste to manufacture ceramic frits and glasses

Examples:

Mullite tubes for kiln use

Col0ured glazes from investment casting waste

http://www.freedigitalphotos.net/images/Bathroom_g188-Bathroom_p6166.html

RockTron Advanced Products

Godfrey Short

Director

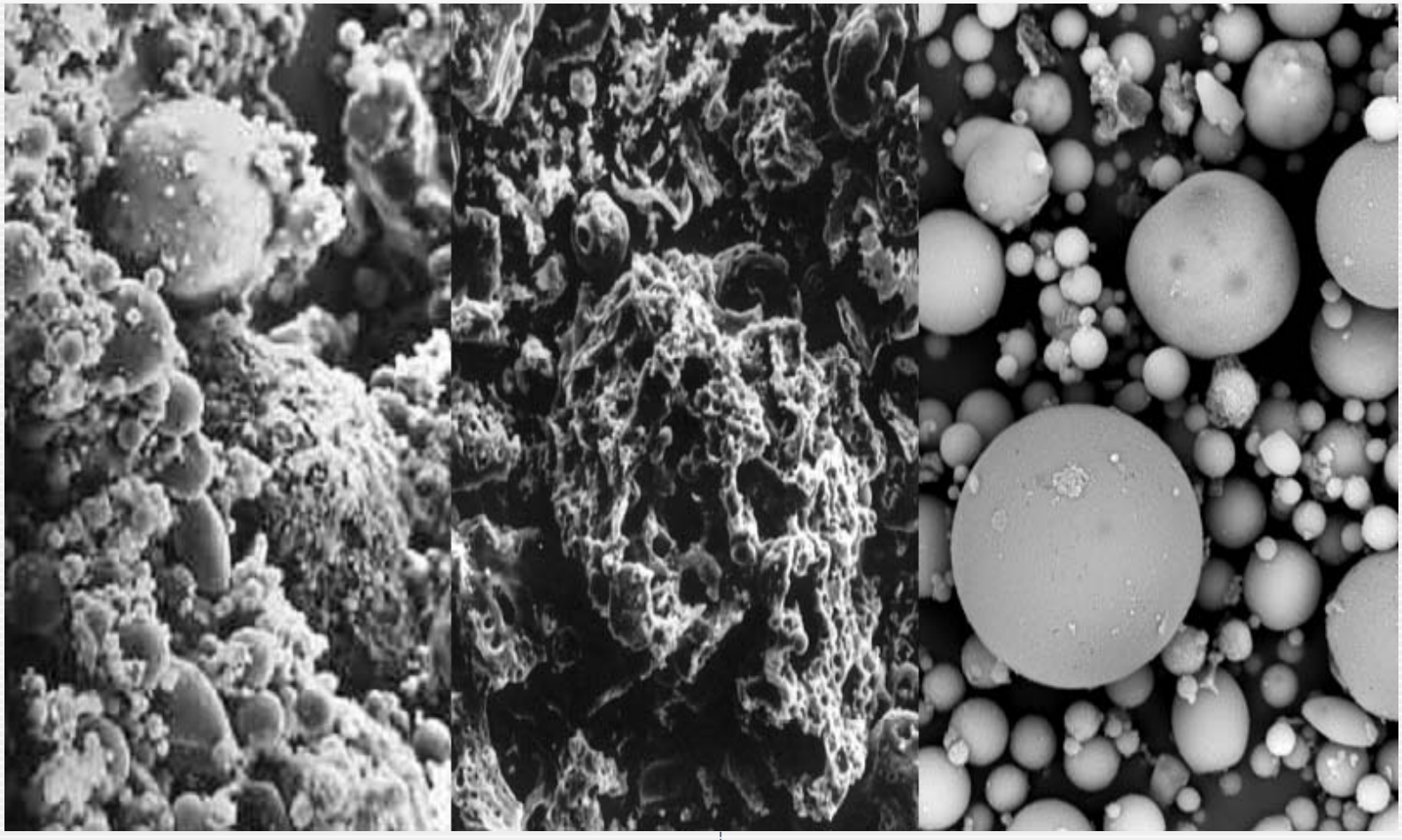
RockTron

RockTron is a Reality!

- A World First: Beneficiation Process
- Significance: Economic and Environmental Benefits.

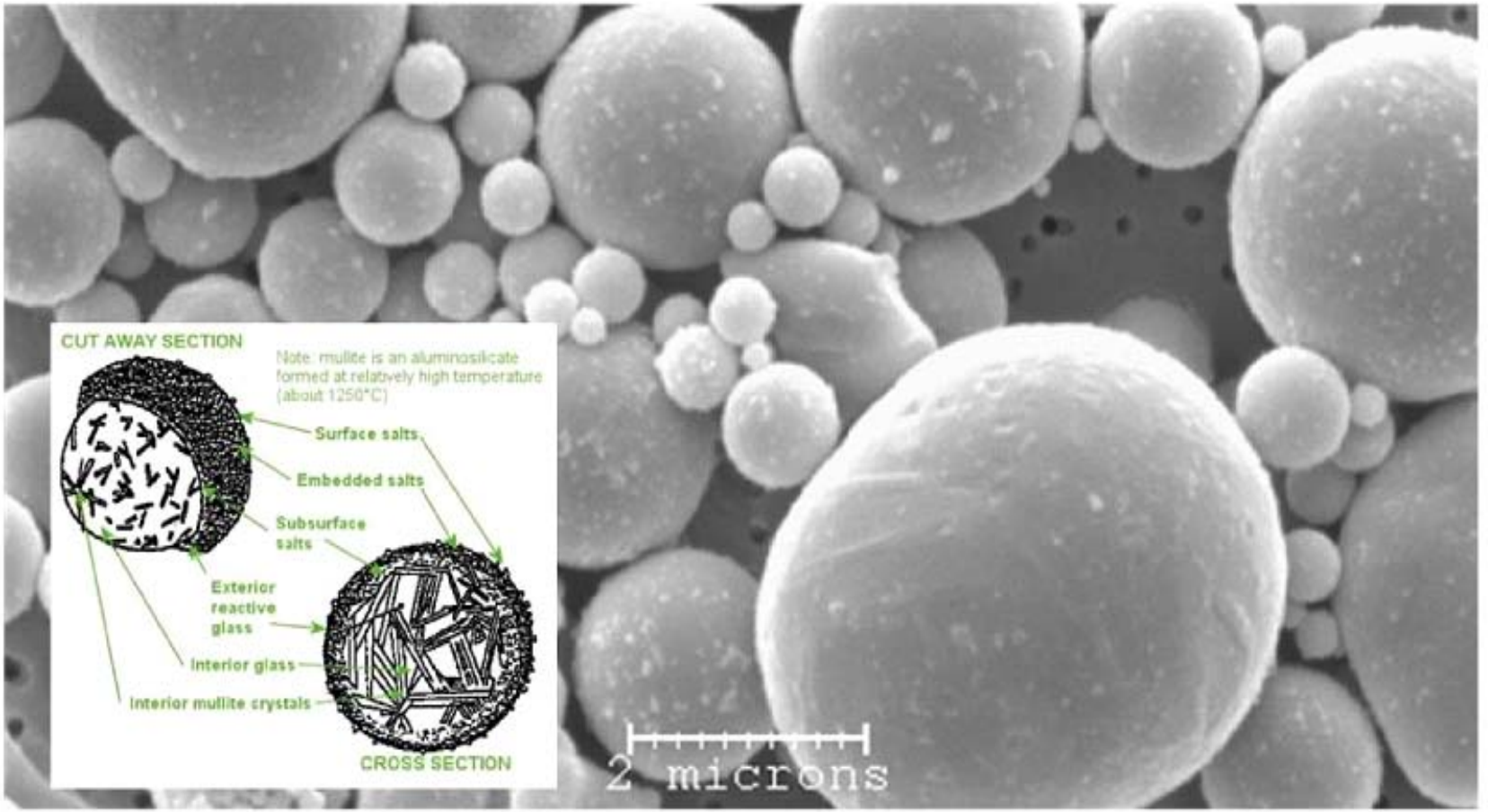
RockTron (Widnes) Ltd

BENEFICIATION



Raw Fly Ash | CarbTron™ | MinTron™

PFA - PULVERISED FUEL ASH



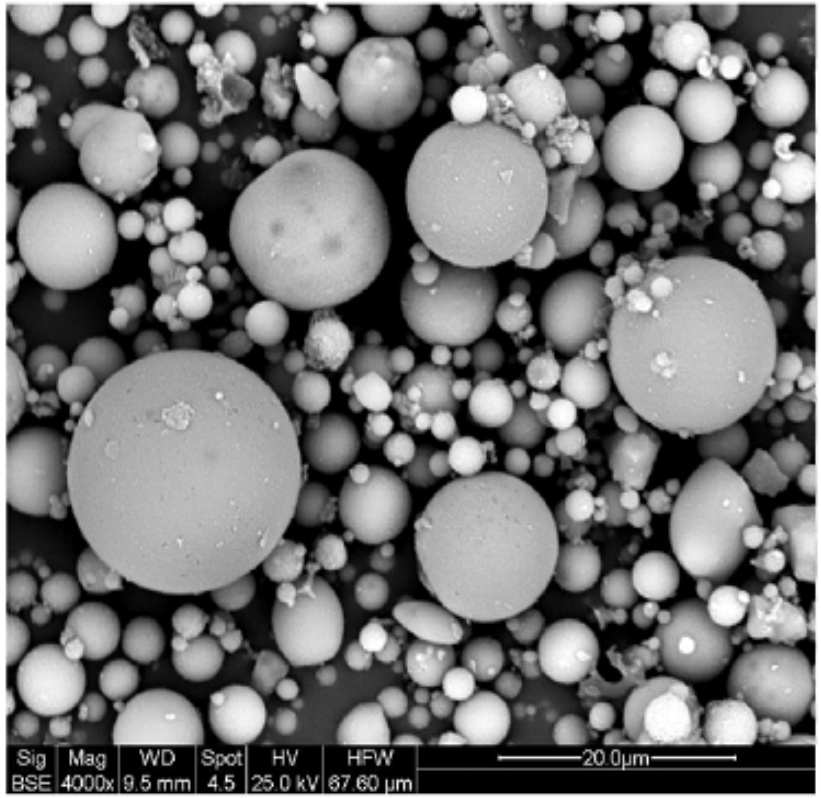
Bespoke Mould Solutions

RockTron

Observations using MinTron™7 in Thermoset materials

EASE OF MIXING - RESULTS

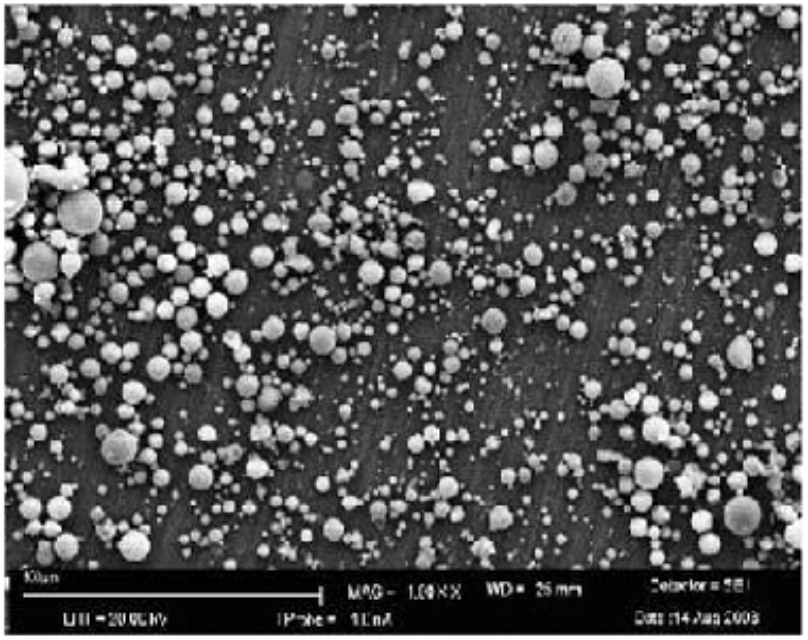
* Homogeneous mix
* Excellent dispersion
* No agglomeration



BENEFITS

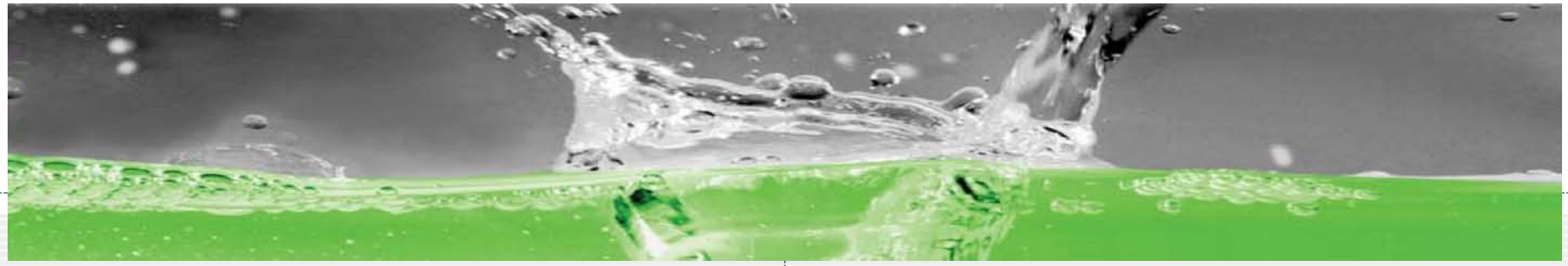
* Reduced energy requirement
* Scope for increased filler content
* Increased output, without change or upgrade of equipment

MagTron™



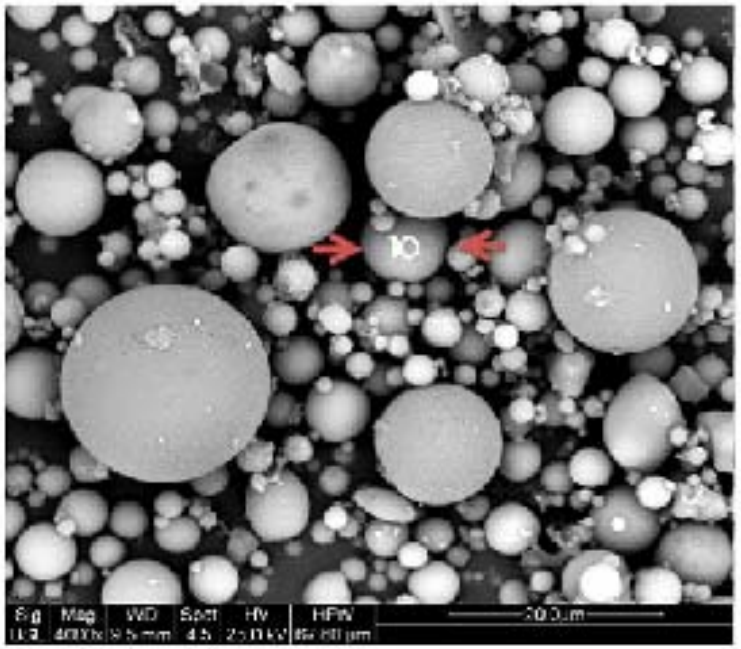
- New spherical magnetite
- Particle density 3.5 - 3.6 g/cm^3
- Particle size range <1µm to 100µm
- Colour black
- Production available 50,000 tonnes p.a.
- Paramagnetic
- Ideal for EMI / RFI shielding and conductive polymers
- Electromagnetic Interference / Radio Frequency Interference

MAGTRON



MinTron™

- Solid alumino-silicate glass spheres
- Particle size range < 1µm to 100µm
- Good Chemical Resistance
- Particle density 2.0 – 2.3g/cc
- Free flowing, hard, smooth
- Spherical shape reduces melt viscosity
- Disperses evenly
- Lowers surface to volume ratio
- Hardness: Mohs Scale 5 - 6



MINTRON

GREENING THE SUPPLY CHAIN

* 100% recycled raw material = eco-minerals
* No waste stream
* Sustainable supply
* Low carbon footprint (kg CO_2 / kg product)

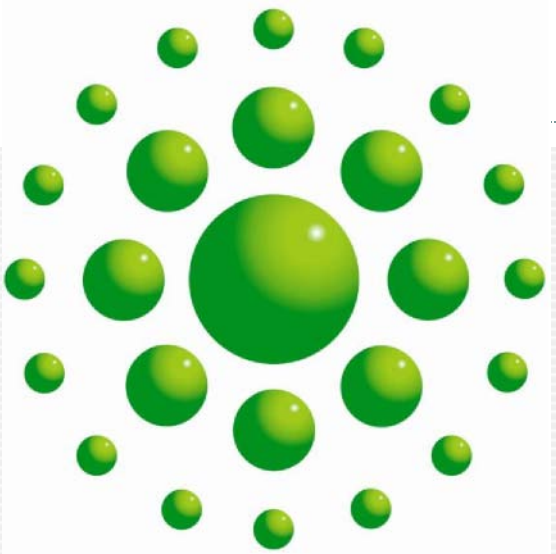
  MinTron **0.08** / Glass / Talc **0.8 – 0.9** / Glass Fibres **1.53**
* Avoids fresh mineral quarrying / crushing / milling
* Reduces landfill / promotes site remediation
* Returns more energy than consumed

RockTron Biocide

Use of RockTron eco-minerals coated with a non-silver microbiocide

ADVANCED PRODUCTS RANGE

Product Description	Particle Size (µm)
CenTron™300 Hollow Glass Spheres	1-300
CenTron™100 Hollow Glass Spheres	1-100
MagTron™FC Magnetite Spheres	1-100
MagTron™100 Magnetite Spheres	1-100
MagTron™10 Magnetite Spheres	10
MagTron™7 Magnetite Spheres	7
MinTron™100 Solid Glass Spheres	1-100
MinTron™70 Solid Glass Spheres	70
MinTron™7 Solid Glass Spheres	7
MinTron™7 SC1 Coated (PA, PBT etc.)	7
MinTron™7 SC2 Coated (PP, PE etc.)	7
MinTron™7 SC3 Coated (Thermosets)	7
MinTron™7 TR Passenger Tyres	7
MinTron™ RTB Biocide coated	



RockTron

POWERFULLY GOOD ECO-MINERALS