

PROBLEM#02

Colors of powder

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Problem statement

observations

Theoretical data

Experimental analysis

conclusion



PROBLEM STATEMENT

If a coloured material is ground to a powder, in some cases the resulting powder may have a different colour to that of the original material. Investigate how the degree of grinding affects the apparent colour of the powder

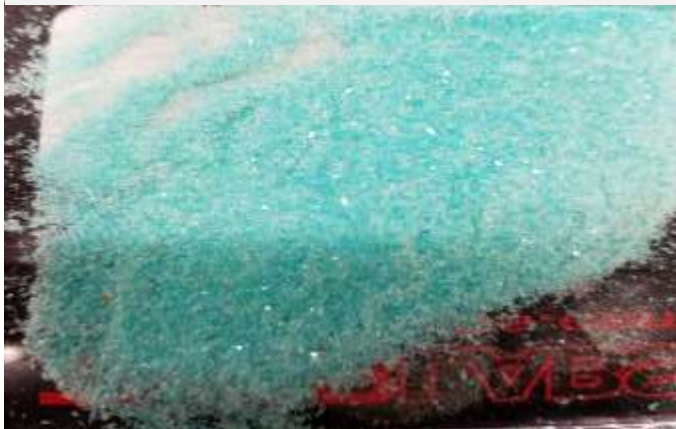


Experimental setup

grow the crystals of the chemicals (potassium ferricyanide, copper sulphate, sodium nitrate)



Collect powder on each sieve



Ground the crystals into smaller particles



Analyse it under microscope in order to determine the sizes and shape of particles



We pile up the sieve from bottom to the top for uniform particle size distribution.



Incident the light on different particles of different chemicals . took the pictures and find out RGB code through software





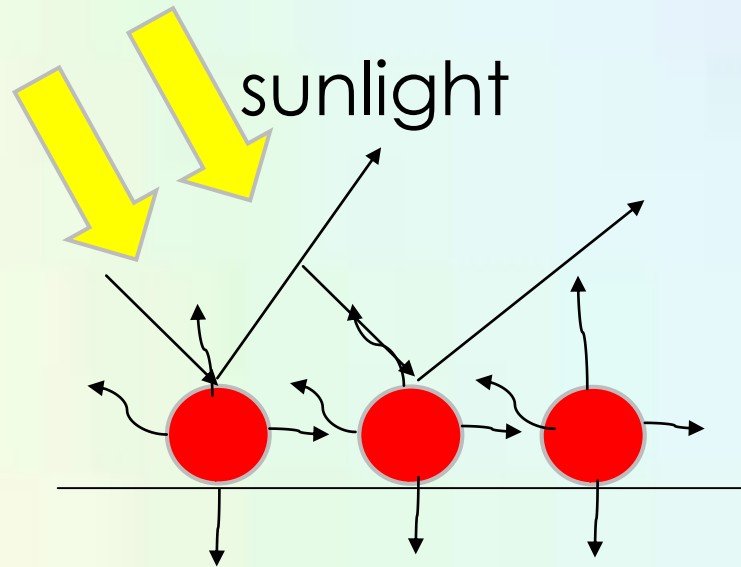
Preliminary observations

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- Different chemical pigments absorb different wavelengths of light
- The colors of particles don't change from different angles when we observe
- Grinding the mirror like crystals will make them whiter and rougher than before
- When light hits the small mirror like crystals it is scattered into many directions

Introduction to colors

- Electromagnetic radiation
- scattering
- Reflection
- Transmission





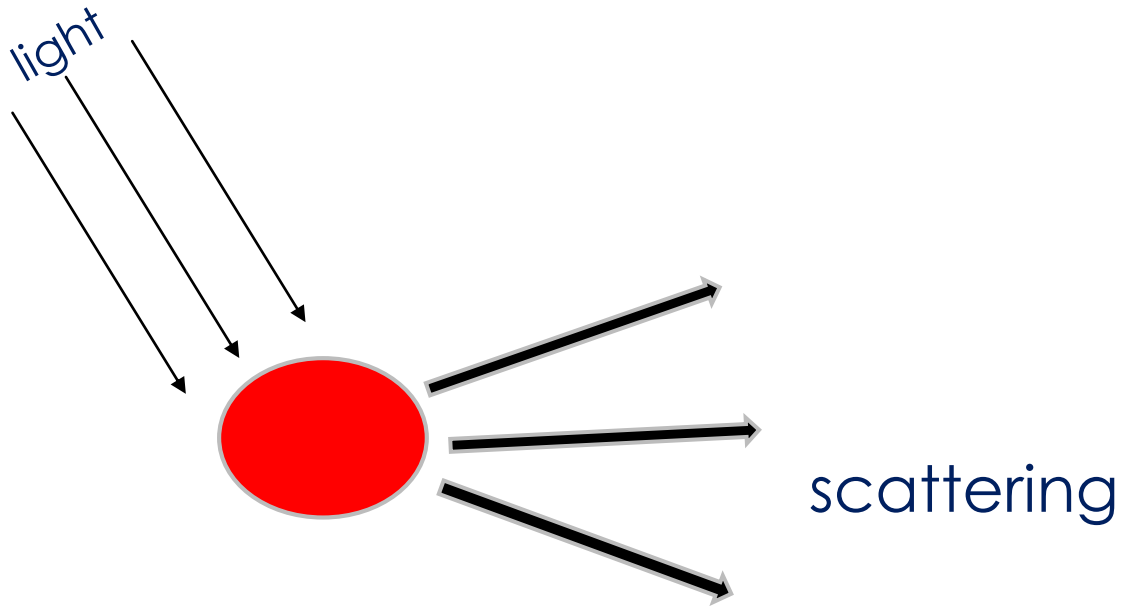
Scattering

Size of scattering particle can be parameterized by

$$x = 2 \pi r / \lambda$$

Wavelength of light

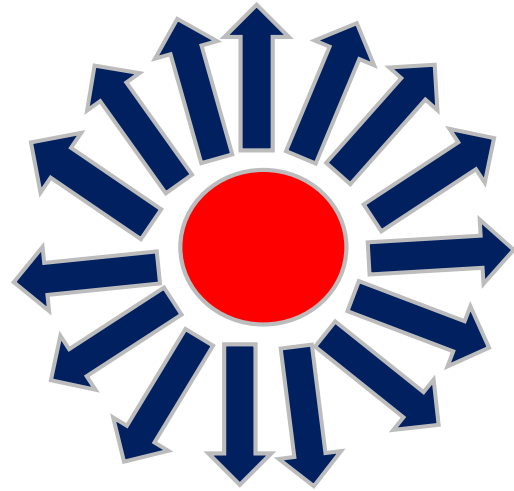
r is the radius of particle



Scattering

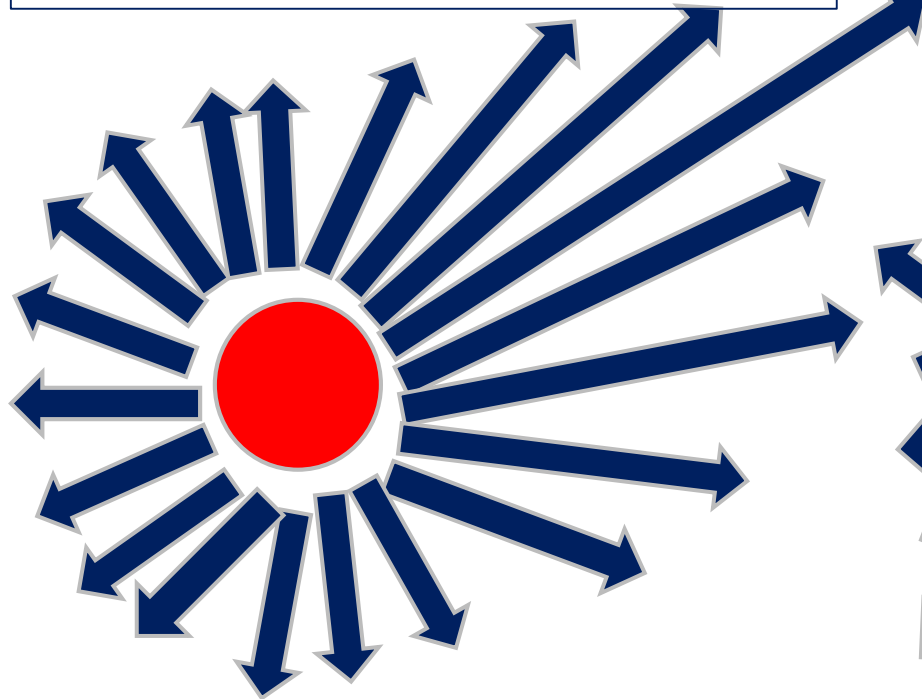
- $x \ll 1$ (Rayleigh scattering)
- $x \approx 1$ (Mie scattering)
- $x \gg 1$ (geometrical scattering)

small particle compared to wavelength of light



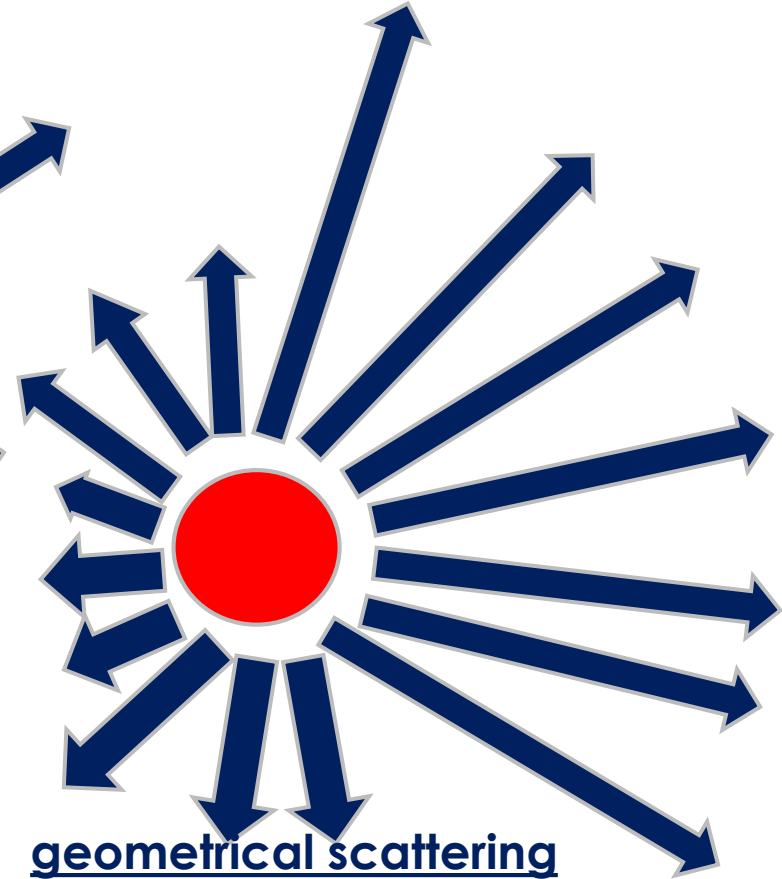
Rayleigh scattering

particle about the same size as wavelength of light



Mie scattering

particle much larger than wavelength of light

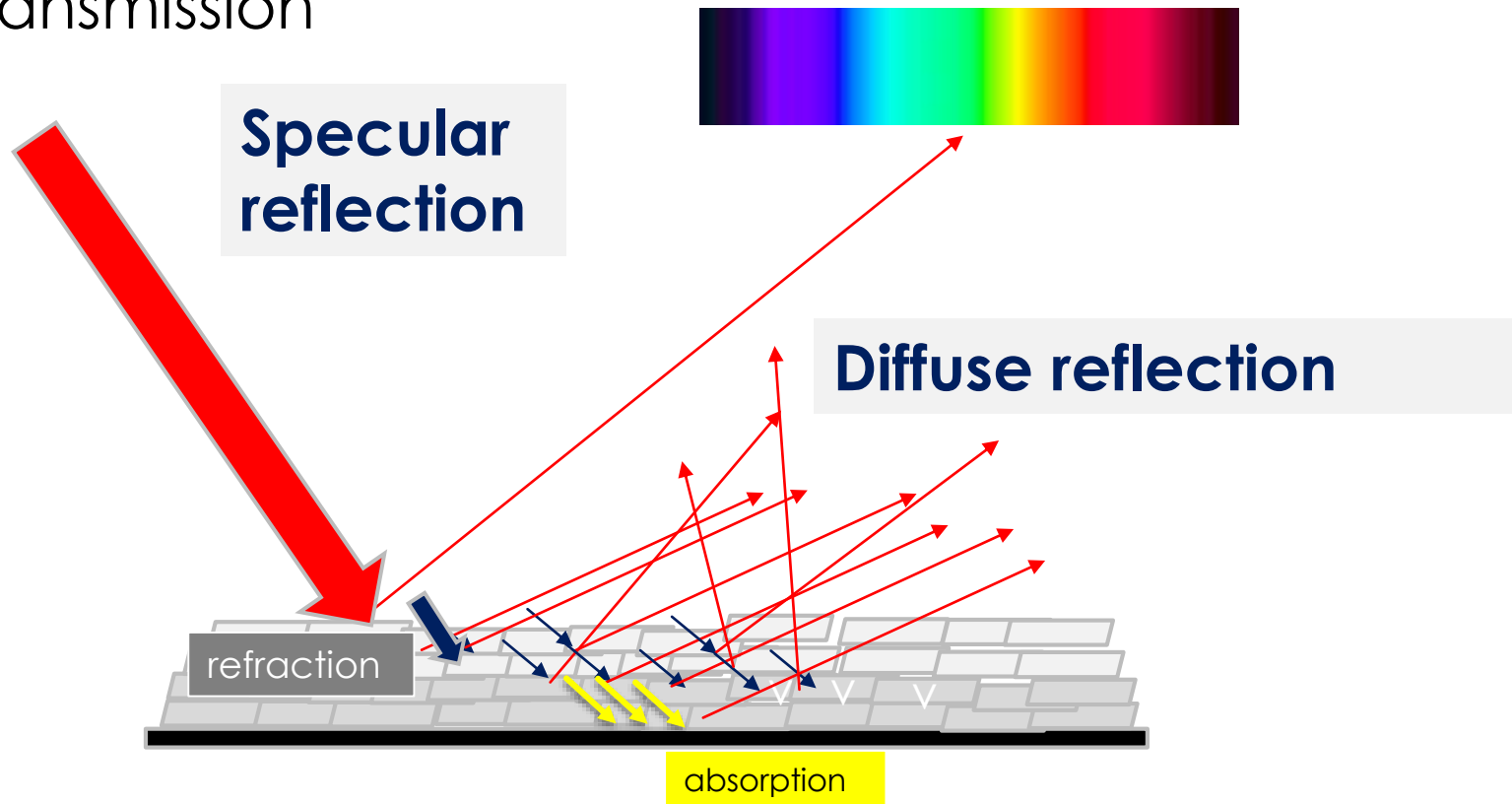


geometrical scattering



Diffuse reflection phenomenon

- Specular reflection
- Refracted
- Scattered (due to internal reflection) → Affect the colour of the object
- transmission



Chemical used : Copper sulphate and potassium ferricyanide

Copper sulphate



Particle size 1

Radius=0.000022m

Particle size 2

Radius=0.0000475m

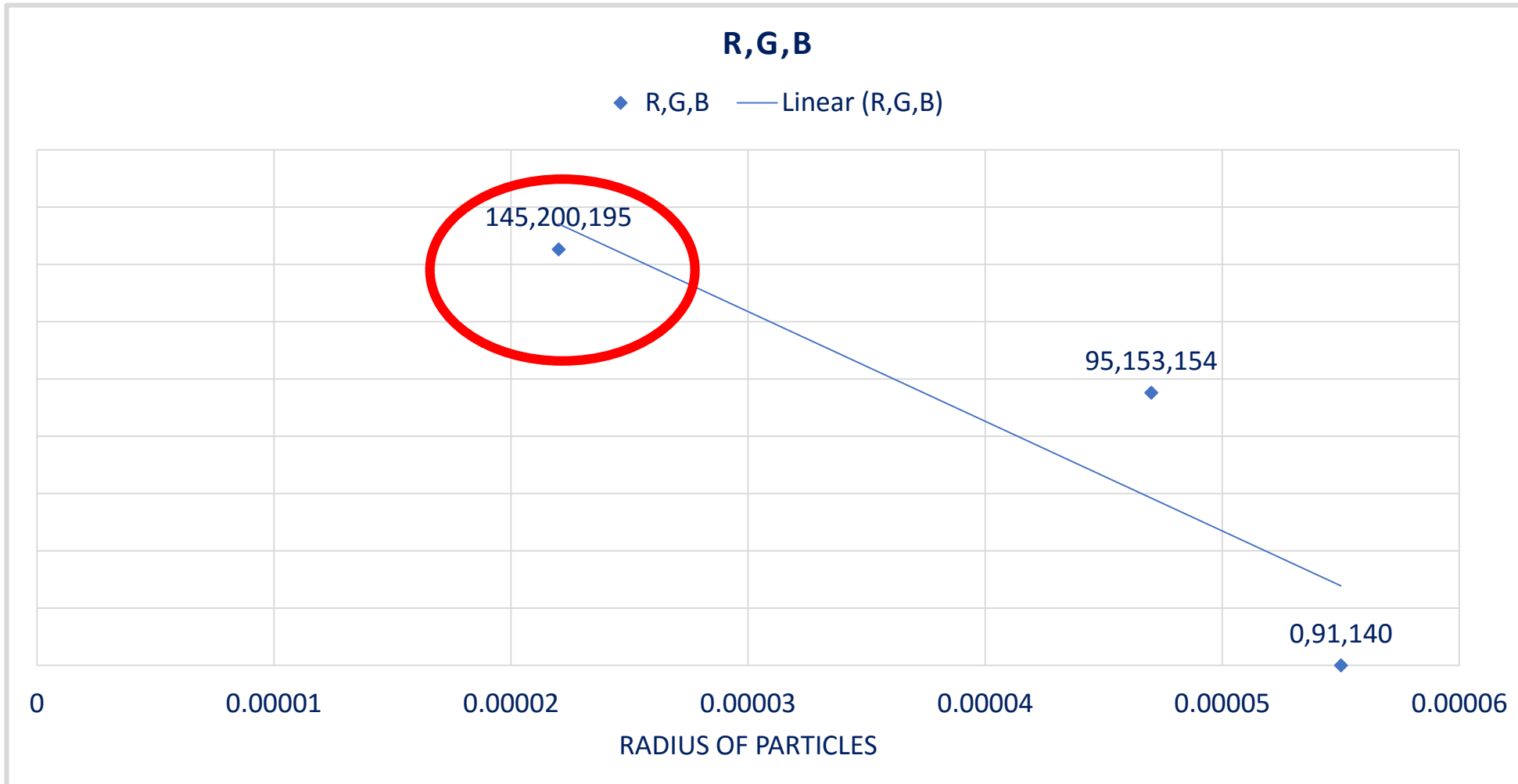
Particle size 3

Radius=0.0000551m



Degrees of grinding

Background : white





Degrees of grinding

Potassium ferricyanide



Particle size 1

Radius=0.000026m

Particle size 2

Radius=0.000035m

Particle size 3

Radius=0.000067m



Analysis

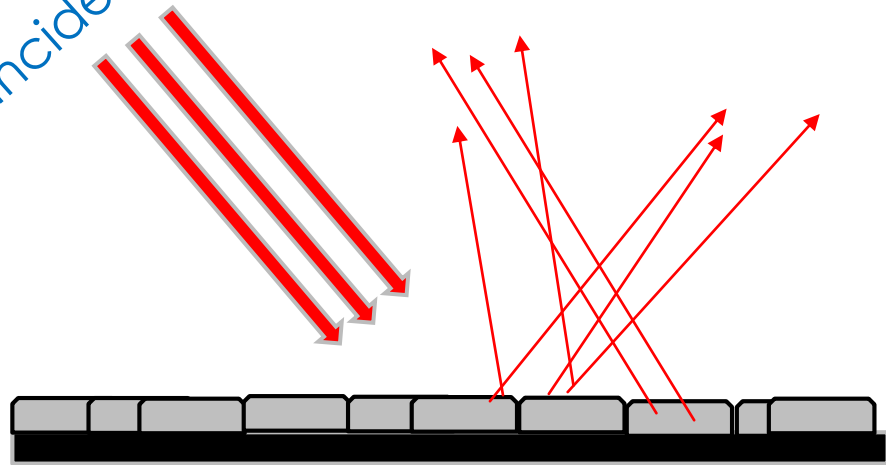
- ✓ Roughness of surface
- ✓ Colours of light
- ✓ Particle size



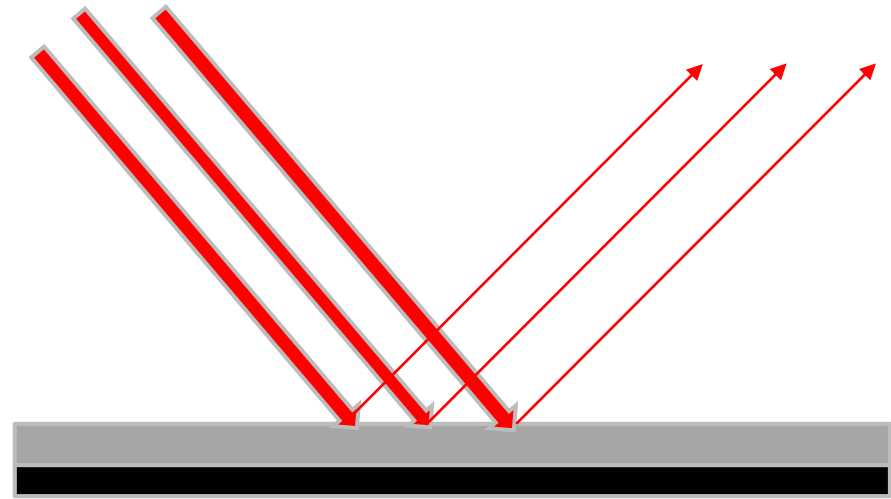
Roughness of surface

➔ Propagation of light

Incident rays



Rough surface of the particle



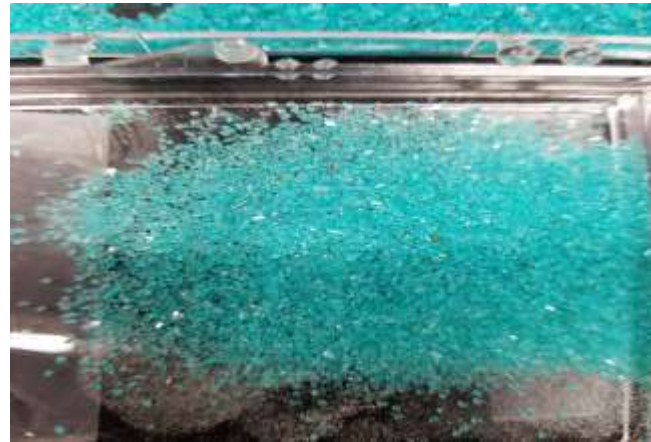
smooth surface of the particle

Sodium nitrate



Particle size 1

Radius=0.000022m



Particle size 2

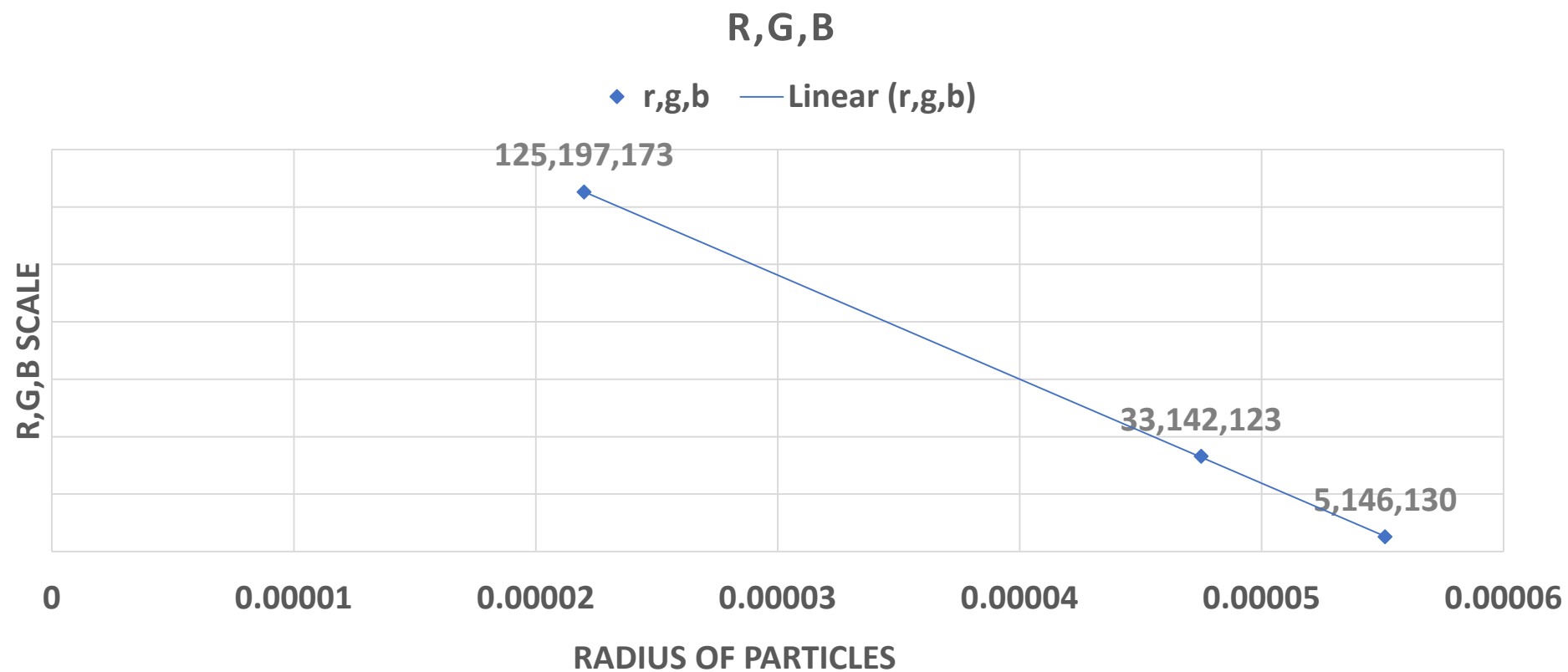
Radius=0.0000475m









Particle size 3

Radius=0.0000551m

Sodium nitrate





Color		Wavelength interval	Frequency interval
	<u>Red</u>	~ 700– 635 nm	~ 430– 480 THz
	<u>Orange</u>	~ 635– 590 nm	~ 480– 510 THz
	<u>Yellow</u>	~ 590– 560 nm	~ 510– 540 THz
	<u>Green</u>	~ 560– 520 nm	~ 540– 580 THz
	<u>Cyan</u>	~ 520– 490 nm	~ 580– 610 THz
	<u>Blue</u>	~ 490–	~ 610–