Preparation of nanoparticles by RF plasma method

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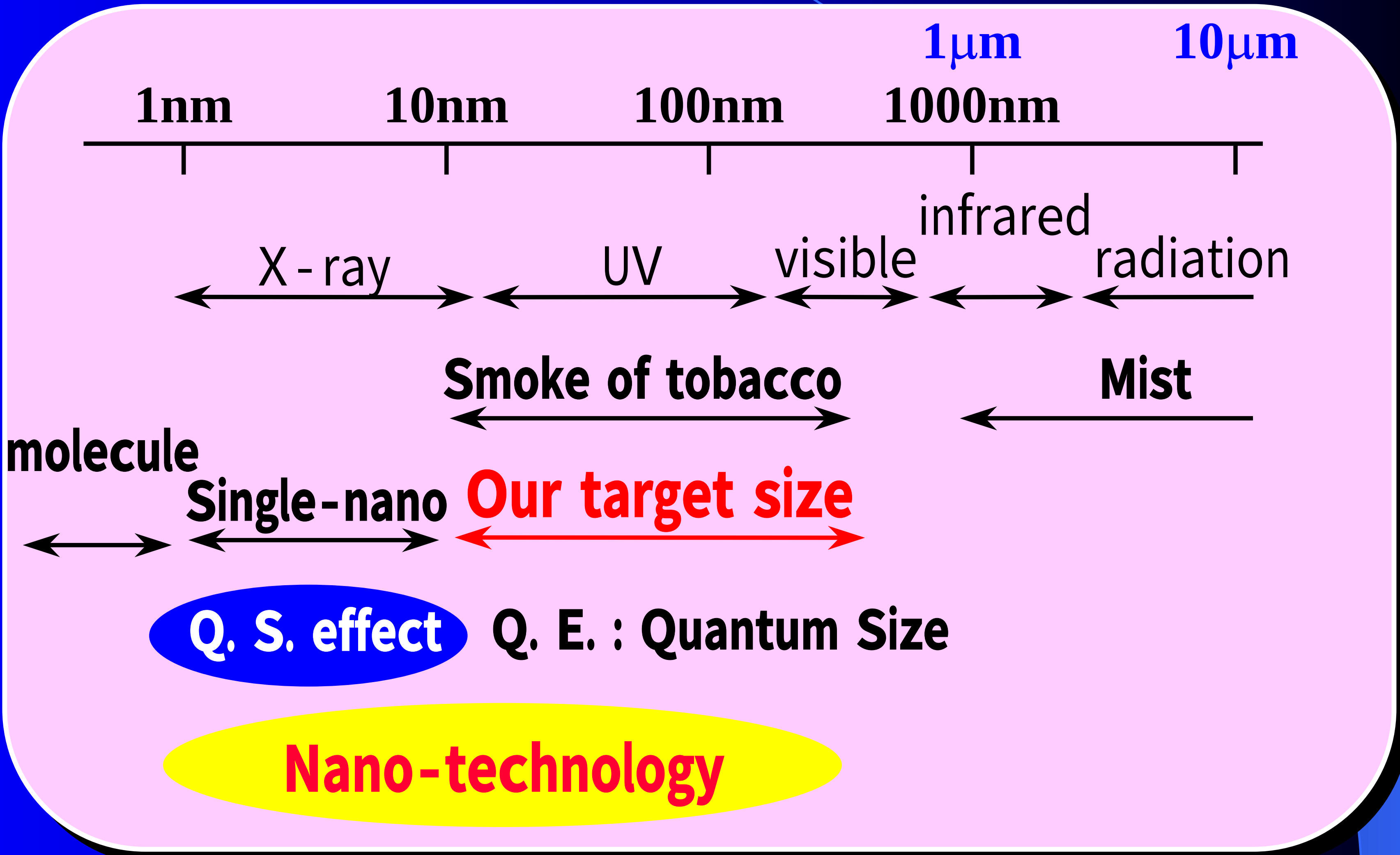
http://www.nisshineng.com

Definition of nanoparticles



What's RF plasma method

RF plasma method are able to produce nanoparticles by vapor phase reactions

RF plasma has a larger frame or reaction volume than the DC

↓

The efficiency of the particle production is higher

Another advantage of RF plasma is the ability to operate without the presence of any electrode

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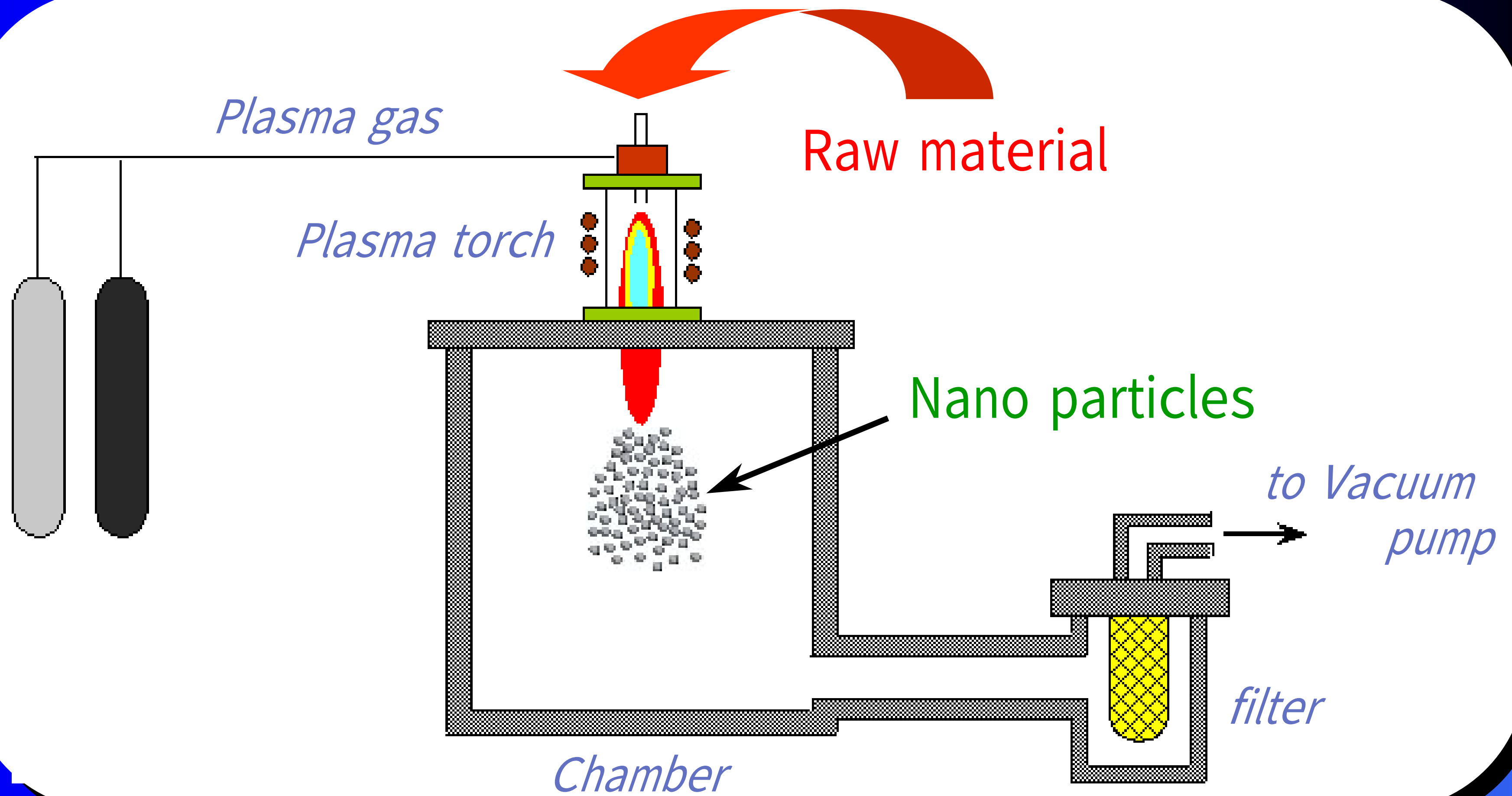
It's enables nanoparticles to be obtained as pure as the raw material without suffering contamination from the evaporation of the electrode

Schematic illustration



Raw material is evaporated instantaneously in high temperature plasma frame

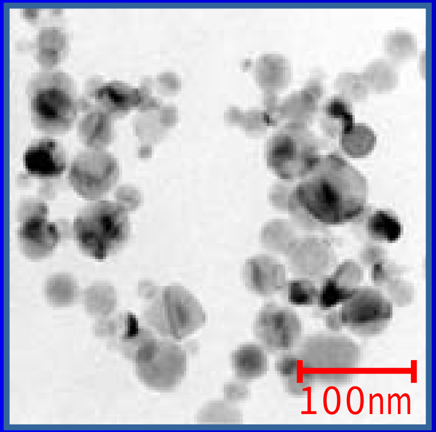
↓

The produced vapor condensed into nanoparticles by subsequent rapid cooling

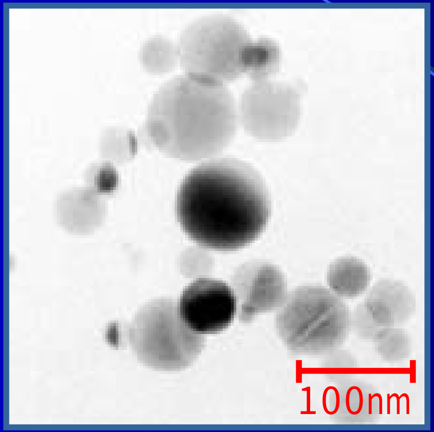
List of prepared nanoparticles

Material	Diameter (BET)	Shape (SEM)	Crystal System (XRD)
SiO_2	10～50nm	Sphere	Amorphous
TiO_2	30～100nm	Sphere	Tetragonal
Y_2O_3	30～80nm	Sphere	Monoclinic
$BaTiO_3$	30～80nm	Sphere	Cubic（Tetragonal）
Ni	50～200nm	Sphere	Cubic
Cu	50～200nm	Sphere	Cubic
TiN	30～60nm	Sphere	Cubic
SiC	30～60nm	anisotropy	Cubic＋Hexagonal

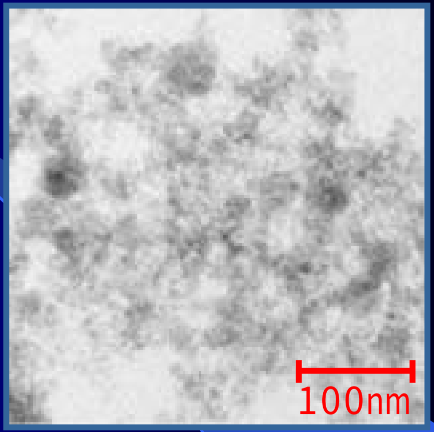
TEM image of nanoparticles



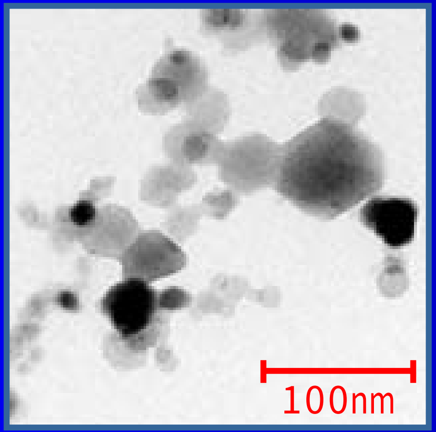
Titania(TiO_2)



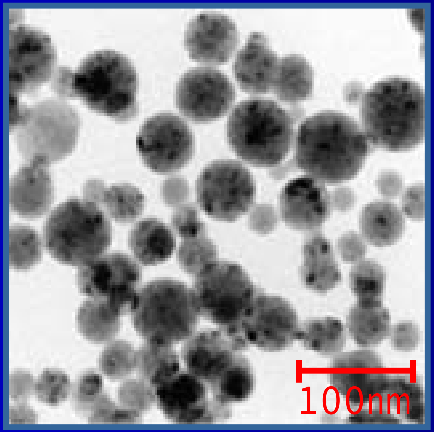
Alumina(Al_2O_3)



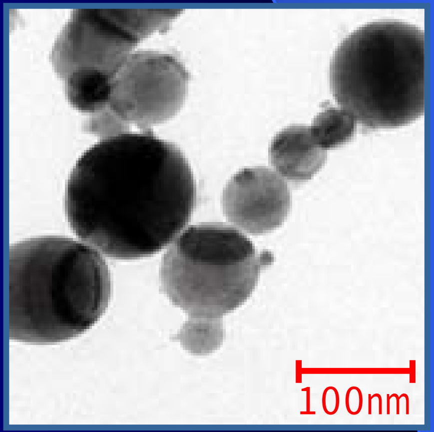
Silica(SiO_2)



Yttria(Y_2O_3)



Barium Titanate($BaTiO_3$)

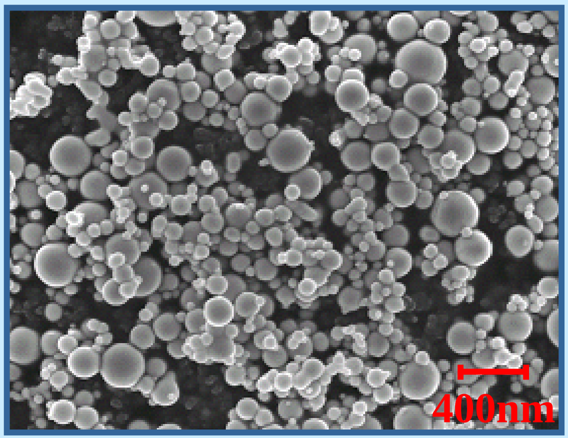


Nickel(Ni)

Metal nanoparticles

Copper nanoparticles

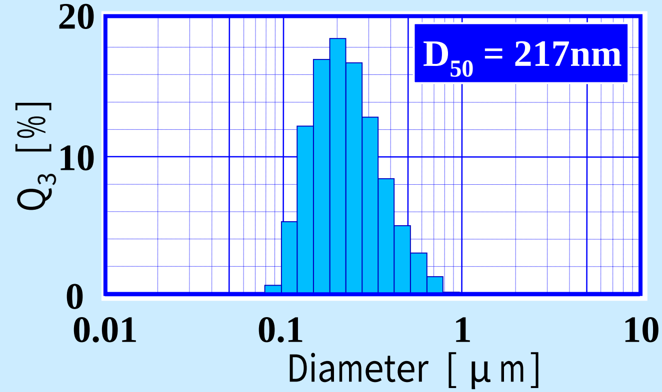
◎ **SEM image**



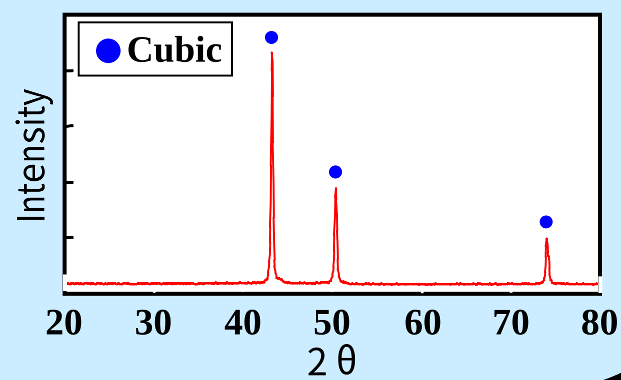
◎ **Specific surface area (BET)**

4.09m²/g
BET-equivalent diameter
164 nm

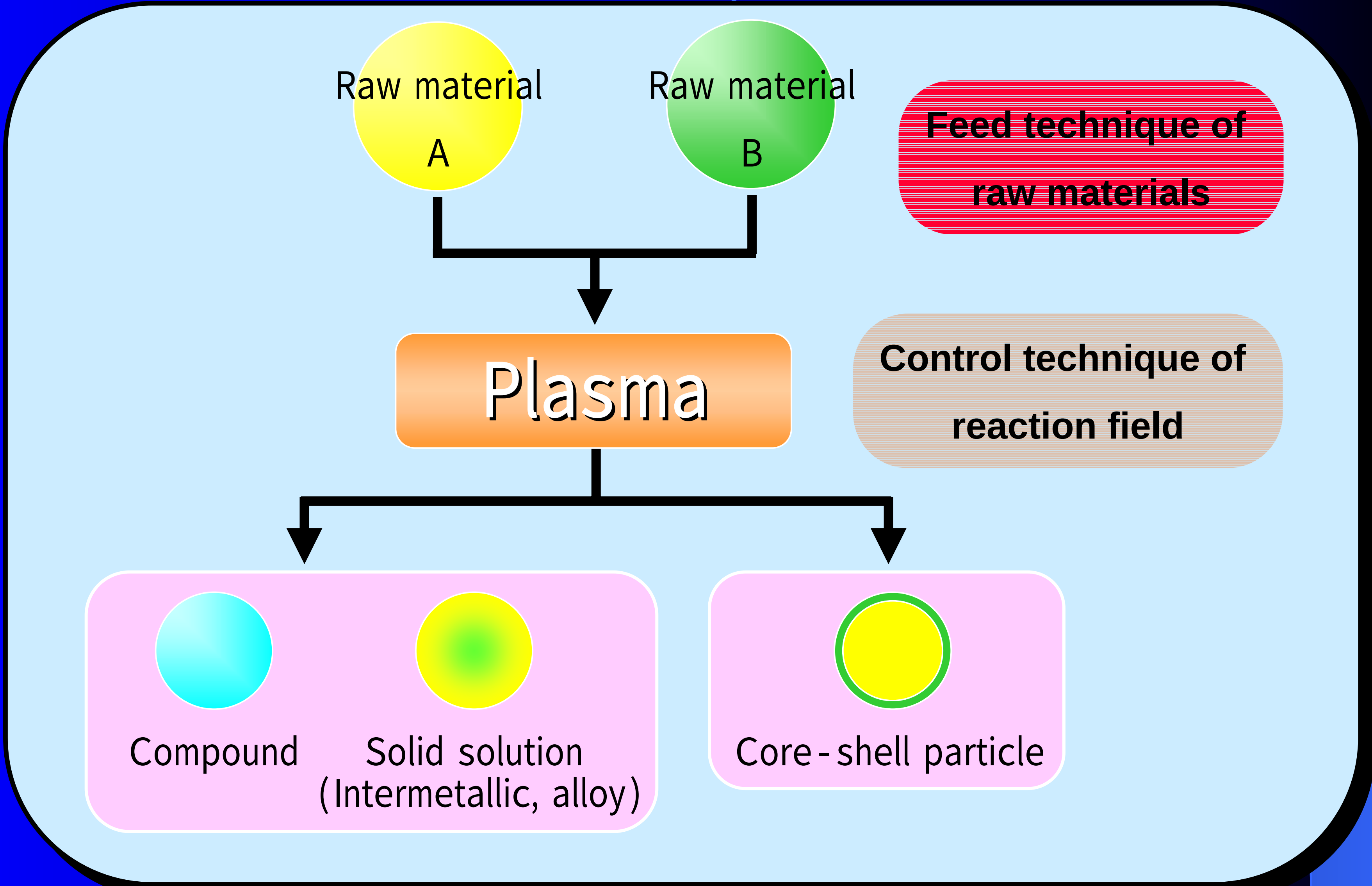
◎ **Laser diffraction**



◎ **X-ray diffraction**



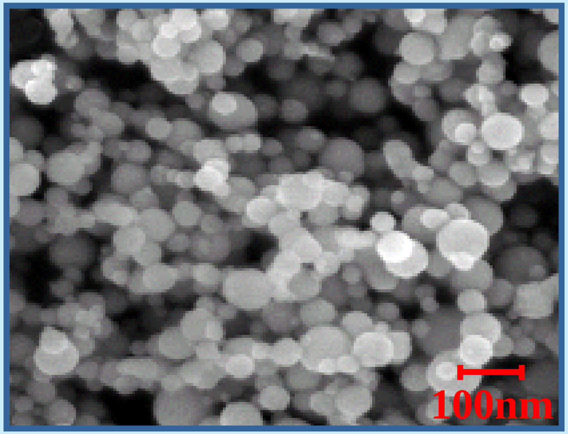
Preparation method of composite nanoparticles



Compound nanoparticles

Barium titanate nanoparticles

◎ **SEM image**



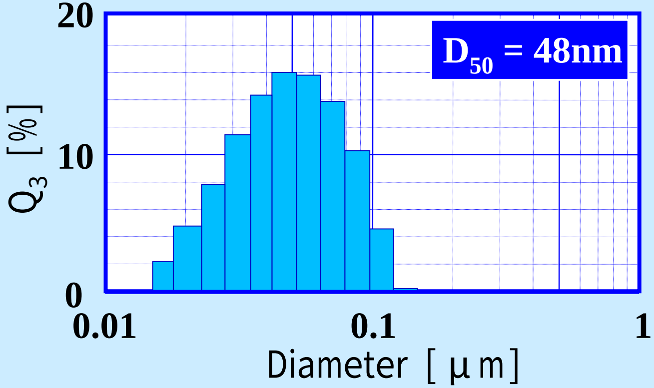
◎ **Specific surface area (BET)**

$23.8 m^2/g$

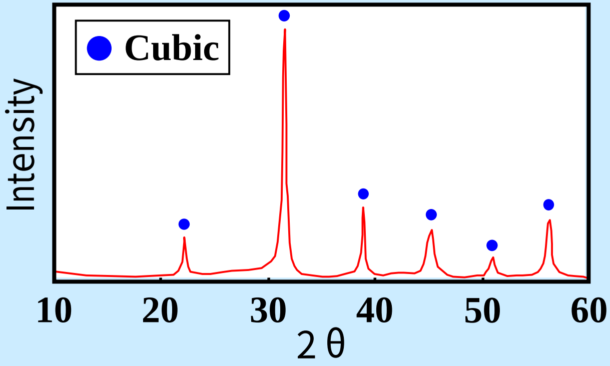
BET-equivalent diameter

42 nm

◎ **Laser diffraction**



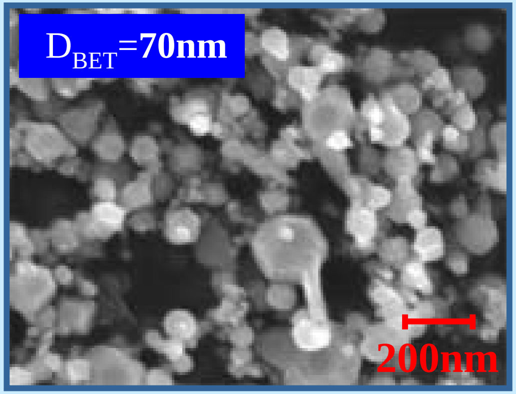
◎ **X-ray diffraction**

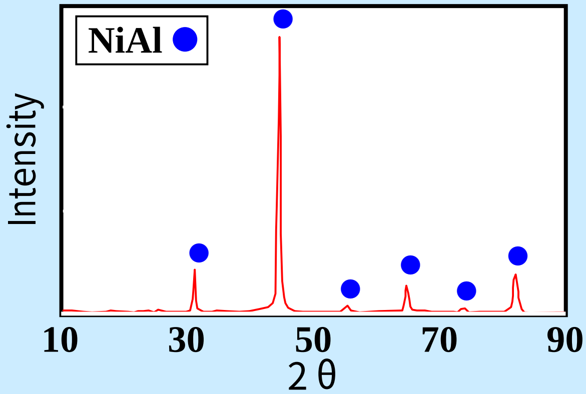


Solid solution nanoparticles ①

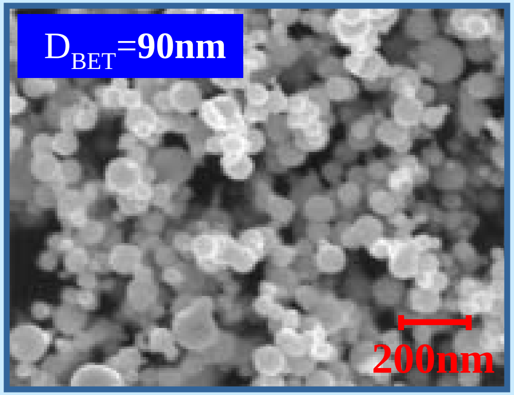
Intermetallic compounds nanoparticles

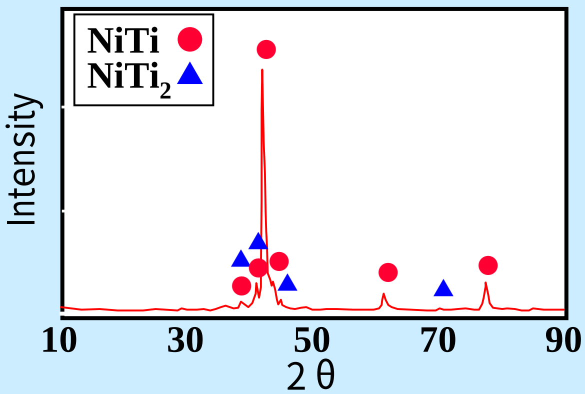
Ni:Al=1:1



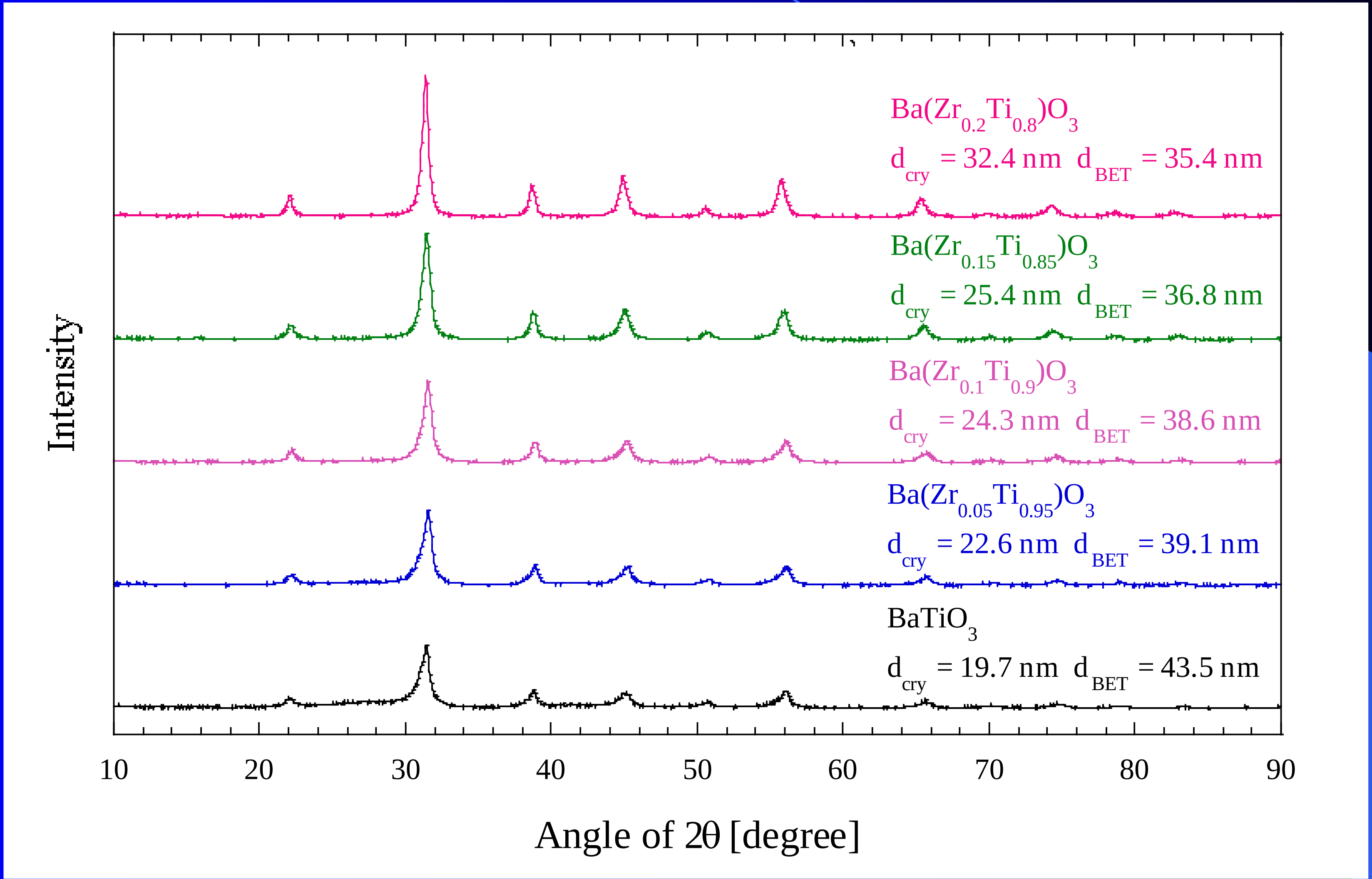


Ni:Ti=1:1



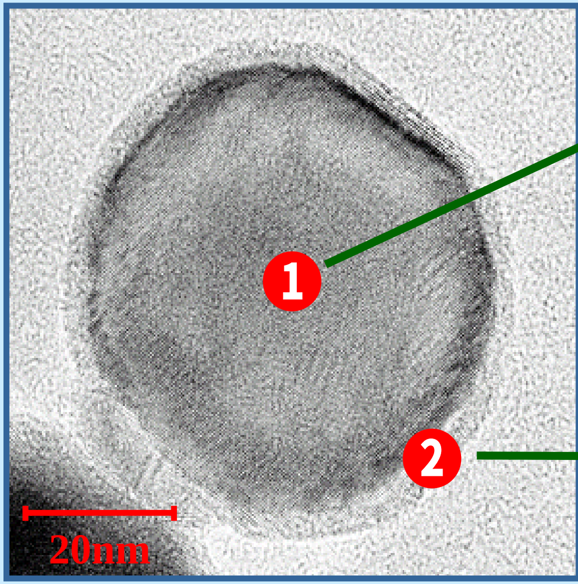


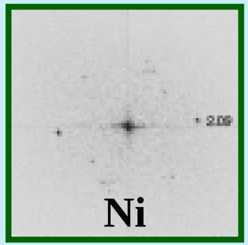
Solid solution nanoparticles ②



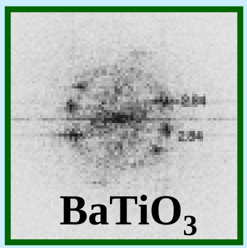
Core-shell nanoparticles

Nickel-Barium titanate composite nanoparticles

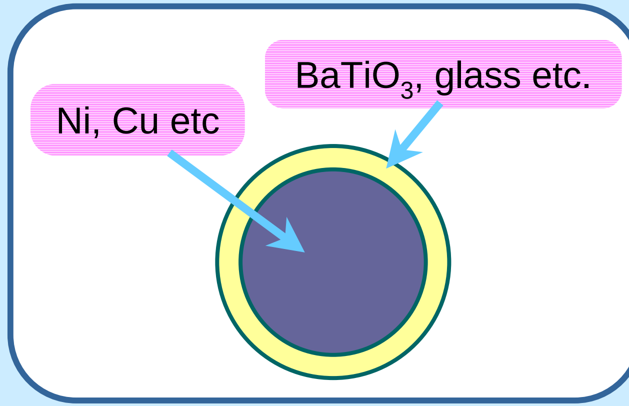




Fourier Transform



Fourier Transform



◎ Purpose

1. Prevention of oxidation of metal nanoparticles
2. Control of sintering process

Analysis of core-shell nanoparticles