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Gd_2O_3@SiO_2 nanoparticles with core-shell structure for magnetic resonance imaging and computed tomography

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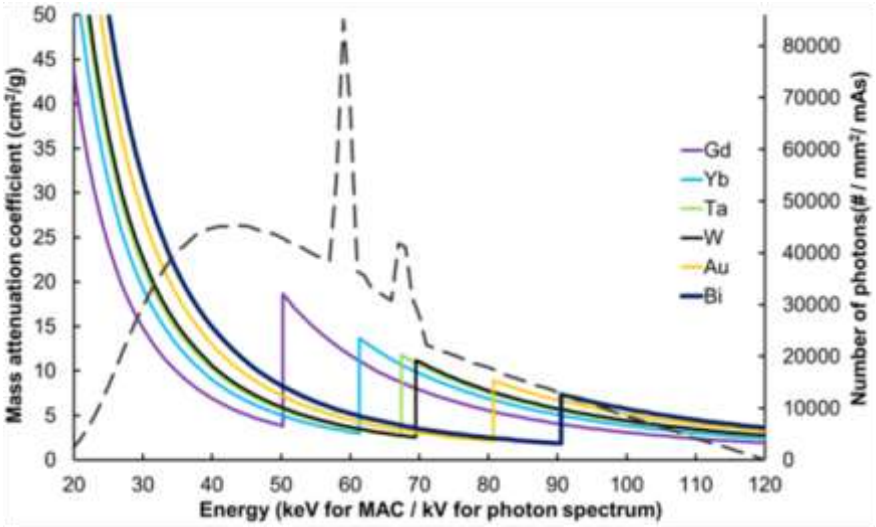
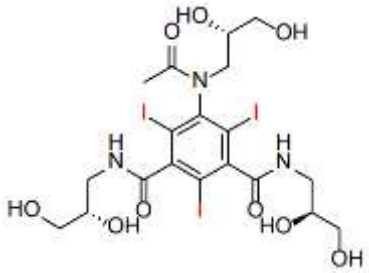
Photon-Counting Computed Tomography



X-ray emission and absorption spectra

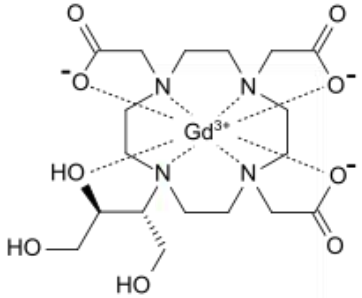
Photon counting detectors

CONTRAST AGENTS



Iohexol
(**Omnipaque®**)

Gadobutrol
(**Gadovist®**)



37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn						

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Er	68 Tm	69 Tm	70 Yb	71 Lu

Toxicity, radioactivity

Have been used clinically or described in the literature as CAs

Synthesis of gadolinium oxide

I

$$Gd(NO_3)_3 + 3NaOH \rightarrow Gd(OH)_3 + 3NaNO_3$$

$$2Gd(OH)_3 \xrightarrow{t^o} Gd_2O_3 + 3H_2O$$

Sol-gel method:
1) Producing a $Gd(OH)_3$ sol
2) Solvent removing
3) Thermal decomposition in an air atmosphere

https://doi.org/10.1016/j.radphyschem.2020.109212

II

$$2Gd(NO_3)_3 + 3(NH_4)_2C_2O_4 \rightarrow Gd_2(C_2O_4)_3 + 6NH_4NO_3$$

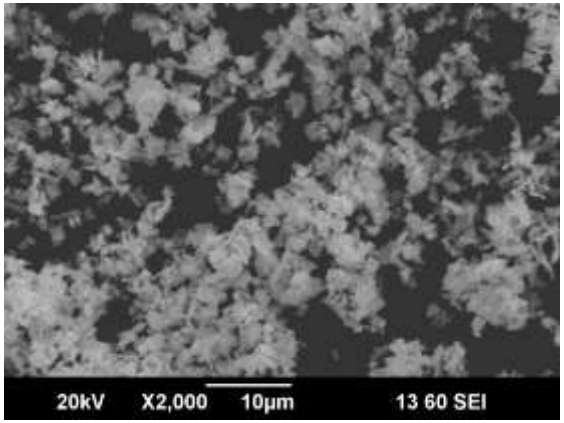
$$Gd_2(C_2O_4)_3 \xrightarrow{t^o} Gd_2O_3 + 3CO + 3CO_2$$

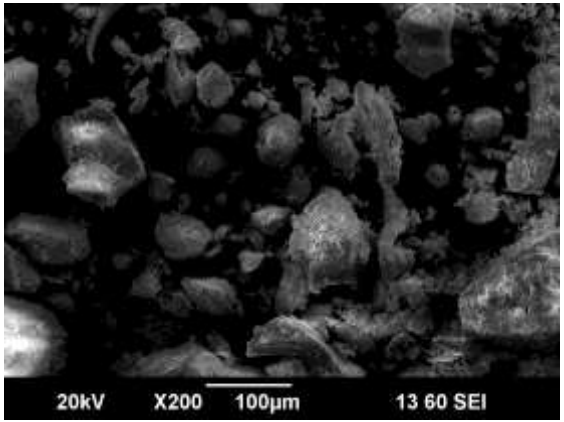
Precipitation in water solution:
1) Precipitation of $Gd_2(C_2O_4)_3$
2) Thermal decomposition in an air atmosphere

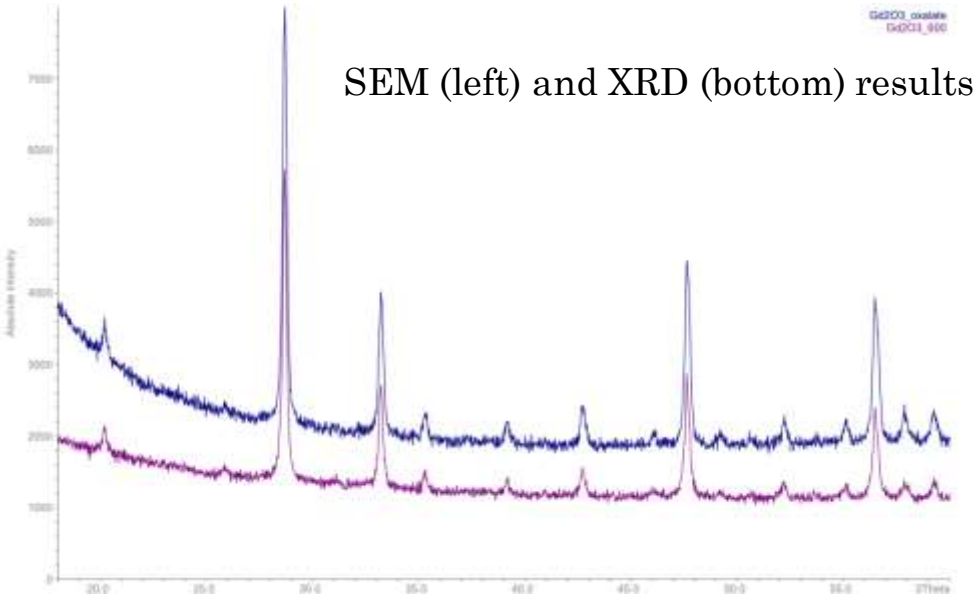
Methods of studying: XRD, SEM

https://doi.org/10.1016/S0927-7757(01)01091-3

Synthesis of gadolinium oxide







SEM (left) and XRD (bottom) results

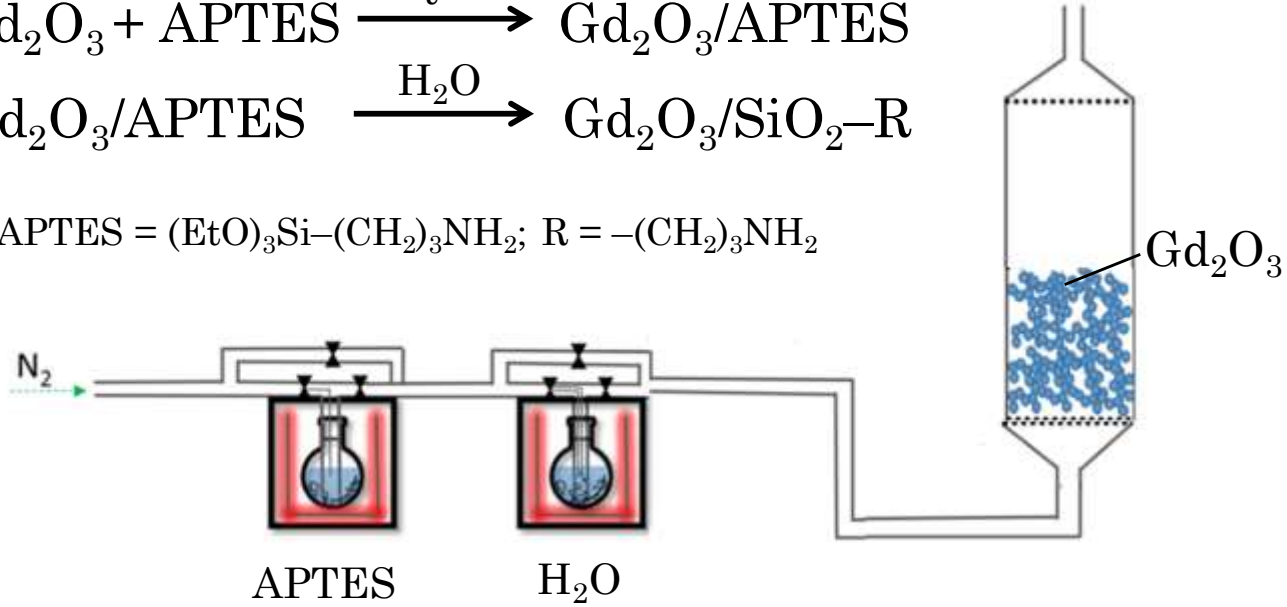
№	Precursor	T, °C	L, nm
1	$Gd(OH)_3$	600	8
2	$Gd(OH)_3$	700	10
3	$Gd_2(C_2O_4)_3$	600	7

GAS-PHASE MODIFICATION

$$Gd_2O_3 + APTES \xrightarrow{t^o} Gd_2O_3/APTES$$

$$Gd_2O_3/APTES \xrightarrow{H_2O} Gd_2O_3/SiO_2–R$$

APTES = $(EtO)_3Si–(CH_2)_3NH_2$; R = $–(CH_2)_3NH_2$



T, °C	t_{tr}, min
150	5
	10
	30
200	5
	10
	30
250	5
	10
	30

Methods of studying:
TG, TEM, SEM, IR, XPS

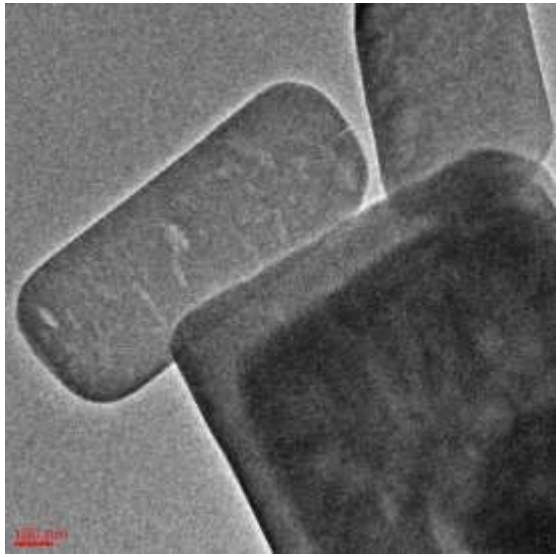
https://doi.org/10.1021/acs.langmuir.0c03647

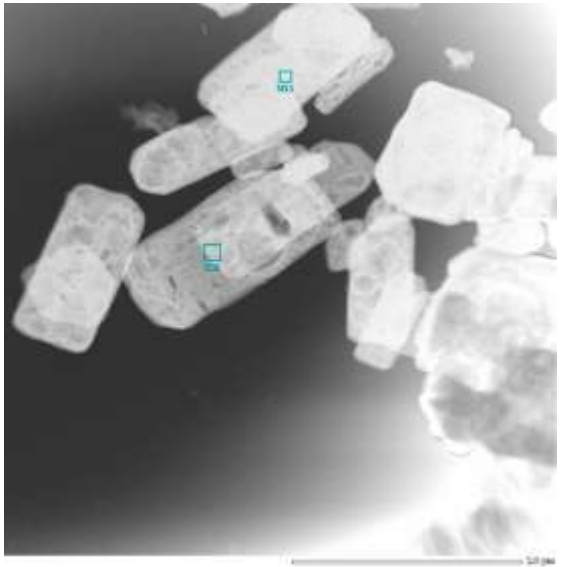
Modification using water solution

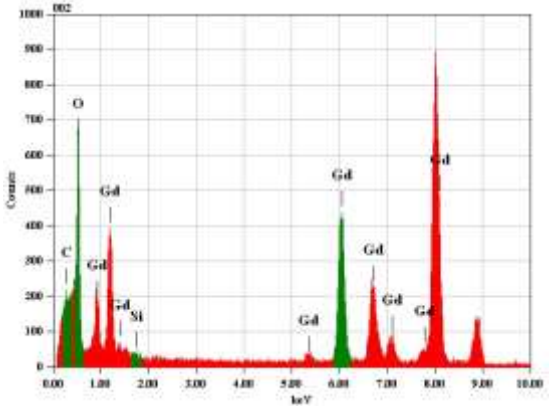
Precipitation of gadolinium oxalate and hydrolysis of TEOS:

1) $2Gd(NO_3)_3*6H_2O + 3(NH_4)_2C_2O_4*H_2O = Gd_2(C_2O_4)_3*10H_2O + 6NH_4NO_3 + 5H_2O$

2) $(EtO)_4Si + 2H_2O = SiO_2 + 4EtOH$







$Gd_2(C_2O_4)_3$@SiO_2 TEM results

Results

1. Gd_2O_3 nanoparticles were produced using two ways of synthesis
2. The morphology, structure and size of the particles were determined
3. The ways to produce particles with core-shell structure were discussed
4. $Gd_2(C_2O_4)_3@SiO_2$ particles were produced and their core-shell structure was confirmed

Thank you for your attention!