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3.6 FTIR spectra of (a) GG and (b) Ag/GG

3.7 Absorption spectra of the Ag nanoparticles formed upon irradiation at various GG concentrations: (a) 0.1, (b) 0.2, (c) 0.3, (d) 0.4, and (e) 0.5% w/v

3.8 Changes in the surface plasmon resonance band of the Ag nanoparticles upon irradiation at various Ag$^+$ precursor concentrations: (a) $5 \times 10^{-4}$, (b) $1.0 \times 10^{-3}$, (c) $2.0 \times 10^{-3}$ and (d) $3.0 \times 10^{-3}$ mol dm$^{-3}$

3.9 Absorption spectra of the Ag nanoparticles formed upon irradiation at various pH values of the solution: (a) 2.6, (b) 4.8, (c) 5.9, (d) 7.2, (e) 9.1, (f) 10.9, and (g) 11.4

3.10 Formation of the Ag clusters in the presence of various alcohols used for scavenging OH radicals: (a) no alcohol, (b) methanol, (c) ethanol, (d) isopropyl alcohol, (e) n-butanol, and (f) tertiary butanol (concentration of alcohol 0.2 mol dm$^{-3}$)

3.11 XRD pattern of Ag/GG

3.12 TEM images of the Ag clusters formed upon irradiation in aqueous GG solution (bar length= 100 nm)

3.13 Thermograms of (a) GG, (b) irradiated GG, and (c) GG irradiated in the presence of Ag$^+$

4.1 Chemical structure of dopamine

4.2 Absorption spectra of aqueous Ag nanoparticle solution at different radiation dose: (a) 0.5 kGy, (b) 1.1 kGy, (c) 1.7 kGy, (d) 1.8 kGy, (e) 2.0 kGy, (f) 2.2 kGy, (g) 2.4 kGy. $\left[\text{Ag}^+ = 1 \times 10^{-3} \text{ mol dm}^{-3}, \text{MA}= 0.1 \text{ mol dm}^{-3}, \text{NaOH}= 0.1 \text{ mol dm}^{-3}, \text{Dose}= 2.2 \text{ kGy h}^{-1}\right]$. Solution was diluted in ratio 1:4 with water before taking spectra

4.3 TEM image of Ag nanoparticles stabilized by poly methacrylate

4.4 Mechanism of Ag nanoparticle formation and stabilization by
polymethacrylate

4.5 FTIR spectra of (a) Methacrylic acid, (b) Ag nanoparticles stabilized by polymethacrylic acid sodium salt [Ag nanoparticles in methacrylic acid synthesized by taking $1 \times 10^{-3}$ mol dm$^{-3}$ AgNO$_3$, 0.2 mol dm$^{-3}$ MA and 0.15 mol dm$^{-3}$ NaOH, dose rate = 2.2 kGy h$^{-1}$, dose = 2.4 kGy]

4.6 Absorption spectra of Ag nanoparticles at different methacrylic acid concentration MA= (a) 0.1 mol dm$^{-3}$, NaOH= 0.1 mol dm$^{-3}$ (b) 0.2 mol dm$^{-3}$, NaOH= 0.2 mol dm$^{-3}$ [Ag$^+$= $1 \times 10^{-3}$ mol dm$^{-3}$, dose rate= 2.2 kGy h$^{-1}$, dose = 2.4 kGy, Solution was diluted in ratio 1:4 with water before taking spectra]

4.7 Absorption spectra of Ag nanoparticles at different AgNO$_3$ concentration Ag$^+$= (a) $1 \times 10^{-3}$ mol dm$^{-3}$, dose = 2.4 kGy (b) 0.2 mol dm$^{-3}$, dose = 4.8 kGy, [MA= 0.2 mol dm$^{-3}$, NaOH= 0.2 mol dm$^{-3}$, Dose rate= 2.2 kGy h$^{-1}$, Solution was diluted in ratio 1:4 with water before taking spectra]

4.8 Absorption spectra of Ag nanoparticle solution in presence of various dopamine concentration (a) 0, (b) $5.27 \times 10^{-7}$, (c) $2.63 \times 10^{-6}$, (d) $4.21 \times 10^{-6}$, (e) $6.32 \times 10^{-6}$, (f) $7.9 \times 10^{-6}$, (g) $1.05 \times 10^{-5}$, (h) $1.58 \times 10^{-5}$ mol dm$^{-3}$ (Inset): Linear plot of absorbance at 450nm versus DA concentration in the range $5.27 \times 10^{-7}$ to $1.58 \times 10^{-5}$ mol dm$^{-3}$

4.9 Absorption spectra of Ag nanoparticle solution in presence of various dopamine concentration (a) 0, (b) $5.27 \times 10^{-7}$, (c) $1.05 \times 10^{-6}$, (d) $2.63 \times 10^{-6}$, (e) $4.21 \times 10^{-6}$, (f) $7.9 \times 10^{-6}$, (g) $1.05 \times 10^{-5}$, (h) $1.58 \times 10^{-5}$ mol dm$^{-3}$ in presence of 1.0 $\times 10^{-4}$ mol dm$^{-3}$ ascorbic acid (Inset): Linear plot of absorbance at 415 nm versus DA concentration in the range $5.27 \times 10^{-7}$ to $1.05 \times 10^{-5}$ mol dm$^{-3}$: (Spectra taken with 0.2 cm path length cuvet)

5.1 Cartoon picture of synthesis of Au seeds from Au$^{III}$ ions in presence of NaBH$_4$ and CTAB
5.2 Absorption spectra of irradiated solution containing $4 \times 10^{-4}$ mol dm$^{-3}$ of Au$^+$, 0.2 mol dm$^{-3}$ isopropanol, 6$\times$10$^{-5}$ mol dm$^{-3}$ of AgNO$_3$, 0.1 mol dm$^{-3}$ of CTAB and 1.2 x $10^{-6}$ mol dm$^{-3}$ seed at various absorbed doses (a) 0.8, (b) 1.7 and (c) 2.6 kGy. Dose rate =3.4 kGy h$^{-1}$

5.3 Absorption spectra of irradiated solution containing $4\times 10^{-4}$ mol dm$^{-3}$ of Au$^+$, 0.2 mol dm$^{-3}$ isopropanol, 8$\times$10$^{-5}$ mol dm$^{-3}$ of AgNO$_3$, 0.1 mol dm$^{-3}$ CTAB and 1.2 x $10^{-6}$ mol dm$^{-3}$ seed at various absorbed doses (a) 1.7, (b) 2.6 (c) 3.0, (d) 3.5 and (e) 4.5 kGy. dose rate = 1.7 kGy h$^{-1}$

5.4 Absorption spectra of irradiated solution containing $4 \times 10^{-4}$ mol dm$^{-3}$ of Au$^+$, 0.2 mol dm$^{-3}$ isopropanol, 8 x $10^{-5}$ mol dm$^{-3}$ of AgNO$_3$, 0.1 mol dm$^{-3}$ of CTAB and 1.2 x $10^{-6}$ mol dm$^{-3}$ seed at various absorbed doses (a) 1.2, (b) 1.6 (c) 2.0, (d) 2.3 and (e) 2.6 kGy. Dose rate = 0.8 kGy h$^{-1}$

5.5 TEM of gold nanorods synthesized by radiolytic method. Bar length = 50 nm

5.6 Absorption spectra of irradiated solution in absence of Ag$^+$ (a) 1.7 and (b) 6.8 kGy. All other conditions are same as mentioned inFigure 5.3

5.7 (a) Cartoon picture of gold nanorod showing (100), (110) side faces and (111) end faces
(b) Schematic representation of zipping mechanism for the growth of gold nanorods in CTAB bi-layer template

5.8 Absorption spectra of irradiated solution containing $1 \times 10^{-4}$ mol dm$^{-3}$ of Au$^+$, 0.2 mol dm$^{-3}$ isopropanol, 8 x $10^{-5}$ mol dm$^{-3}$ of AgNO$_3$, 0.1 mol dm$^{-3}$ of CTAB and 1.2 x $10^{-6}$ mol dm$^{-3}$ seed at various absorbed doses (a) 0.85, (b) 1.06 and (c) 1.2 kGy. Dose rate = 0.8 kGy h$^{-1}$

5.9 Absorption spectra of irradiated solution containing $1 \times 10^{-3}$ mol dm$^{-3}$ of Au$^+$, 0.2 mol dm$^{-3}$ isopropanol, 8 x $10^{-5}$ mol dm$^{-3}$ of AgNO$_3$, 0.1 mol dm$^{-3}$ of CTAB and 1.2 x $10^{-6}$ mol dm$^{-3}$ seed at various absorbed doses (a) 1.28, (b) 2.12 and (c) 3.0, (d) 3.4 and (e) 4.25 kGy. Dose rate = 0.8 kGy h$^{-1}$

5.10 Absorption spectrum of gold nanorods synthesised by the reaction of
Au\(^{I}\) with isopropyl radical in the presence of CTAB. Concentration of
Au\(^{I}\) = 4 \times 10^{-4} \text{ mol dm}^{-3} \text{ and dose} = 2.8 \text{ kGy}, \text{ Dose rate} = 3.4 \text{ kGy h}^{-1}

5.11 Effect of Au\(^{I}\) concentration on nanorod formation: (a) 4 \times 10^{-4} \text{ mol dm}^{-3}, \lambda_{\text{max}} = 701 \text{ nm} \text{ (b) 3} \times 10^{-4} \text{ mol dm}^{-3}, \lambda_{\text{max}} = 715 \text{ nm and (c) 2.5} \times 10^{-4} \text{ mol dm}^{-3}, \lambda_{\text{max}} = 729 \text{ nm. Absorbed dose (a) 2.8 kGy, (b) 2.3 kGy and (c) 1.4 kGy, Dose rate} = 3.4 \text{ kGy h}^{-1}

5.12 Effect of CTAB concentration on nanorod formation: (a) 0.1 \text{ mol dm}^{-3}, \lambda_{\text{max}} = 729 \text{ nm (b) 8} \times 10^{-2} \text{ mol dm}^{-3}, \lambda_{\text{max}} = 699 \text{ nm and (c) 5} \times 10^{-2} \text{ mol dm}^{-3}, \lambda_{\text{max}} = 680 \text{ nm, Dose rate = 3.4 kGy h}^{-1}, [\text{Au}^{I}] = 2.5 \times 10^{-4} \text{ mol dm}^{-3}

5.13 TEM image of gold nanorods prepared by the reduction of Au\(^{I}\) using isopropyl radical generated by gamma radiolysis

5.14 Effect of seed on nanorod formation: (a) in presence of seed [1.28 \times 10^{-6} \text{ mol dm}^{-3}], \lambda_{\text{max}} = 700 \text{nm and (b) in absence of seed, \lambda_{\text{max}} = 685 \text{ nm, Dose rate = 3.4 kGy h}^{-1}, [\text{Au}^{I}] = 4 \times 10^{-4} \text{ mol dm}^{-3}

5.15 Cartoon picture depicting one-pot synthesis of gold nanorods through \textit{in situ} generation of Au seeds in gamma radiation method

5.16 Cartoon picture depicting stepwise synthesis of gold nanorods by external addition of Au seeds in chemical method

5.17 Absorption spectra of gold nanoparticle solutions irradiated at various absorption doses: dose (Gy) = (a) 28.3, (b) 56.6, (c)85, (d) 113.3, (e) 170 for 4 \times 10^{-4} \text{ mol dm}^{-3} \text{ Au}^{\text{III}}, 7.2 \times 10^{-4} \text{ mol dm}^{-3} \text{ ascorbic acid, 0.1 mol dm}^{-3} \text{ CTAB, 6} \times 10^{-5} \text{ mol dm}^{-3} \text{ Ag}^{+}, 0.2 \text{ mol dm}^{-3} \text{ isopropanol and dose rate of 56.6 Gy/min}

5.18 TEM image of rectangular plate like gold nanoparticles

5.19 Proposed schematic of rectangular plate like gold nanoparticle formation

5.20 Absorption spectra of (a) growth solution containing Au\(^{\text{III}}\) before addition of ascorbic acid, (b) growth solution containing Au\(^{I}\) before irradiation. Absorption spectra of gold nanoparticle solutions, kinetics
of growth of particles: time (in minutes) = (c) 15, (d) 20, (e) 25, (f) 30, (g) 35, (h) 45, (i) 65, for $4 \times 10^{-4}$ mol dm$^{-3}$ Au$^{III}$, $7.2 \times 10^{-4}$ mol dm$^{-3}$ ascorbic acid, 0.1 mol dm$^{-3}$ CTAB, 6 $\times$ $10^{-5}$ mol dm$^{-3}$ Ag$^+$, 0.2 mol dm$^{-3}$ isopropanol and absorption dose of 56.6 Gy

5.21 Absorption spectra of gold nanoparticle solutions for different ascorbic acid/Au$^{III}$: (a) AA/Au$^{III}$ = 1.6, (b) AA/Au$^{III}$ = 1.8 and (c) AA/Au$^{III}$ = 2, for $4 \times 10^{-4}$ mol dm$^{-3}$ Au$^{III}$, 0.1 mol dm$^{-3}$ CTAB and 0.2 mol dm$^{-3}$ isopropanol and absorption dose of 56.6 Gy

5.22 Absorption spectra of gold nanoparticle solutions, Au$^{III}$ concentration variation: (a) [Au$^{III}$] = $1.06 \times 10^{-4}$ mol dm$^{-3}$, (b) [Au$^{III}$] = $2.55 \times 10^{-4}$ mol dm$^{-3}$, (c) [Au$^{III}$] = $4 \times 10^{-4}$ mol dm$^{-3}$, (d) [Au$^{III}$] = $4.9 \times 10^{-4}$ mol dm$^{-3}$, (e) [Au$^{III}$] = $5.96 \times 10^{-4}$ mol dm$^{-3}$ and (f) [Au$^{III}$] = $1 \times 10^{-3}$ mol dm$^{-3}$, for $7.2 \times 10^{-4}$ mol dm$^{-3}$ ascorbic acid, 0.1 mol dm$^{-3}$ CTAB, 6 $\times$ $10^{-5}$ mol dm$^{-3}$ Ag$^+$, 0.2 mol dm$^{-3}$ isopropanol and absorption dose of 56.6 Gy

5.23 Absorption spectra of gold nanoparticle solutions, AgNO$_3$ concentration variation: (a) No [Ag$^+$], (b) [Ag$^+$] = $1 \times 10^{-5}$ mol dm$^{-3}$, (c) [Ag$^+$] = $3 \times 10^{-5}$ mol dm$^{-3}$, (d) [Ag$^+$] = $6 \times 10^{-5}$ mol dm$^{-3}$, (e) [Ag$^+$] = $8 \times 10^{-5}$ mol dm$^{-3}$, (f) [Ag$^+$] = $1 \times 10^{-4}$ mol dm$^{-3}$ and (g) [Ag$^+$] = $3 \times 10^{-4}$ mol dm$^{-3}$, for $4 \times 10^{-5}$ mol dm$^{-3}$Au$^{III}$, $7.2 \times 10^{-4}$ mol dm$^{-3}$ ascorbic acid, 0.1 mol dm$^{-3}$ CTAB, 0.2 mol dm$^{-3}$ isopropanol and absorption dose of 56.6 Gy

5.24 Absorption spectra of gold nanoparticle solutions, CTAB concentration variation: (a) [CTAB] = 0.1 mol dm$^{-3}$, (b) [CTAB] = $7 \times 10^{-2}$ mol dm$^{-3}$, (c) [CTAB] = $5 \times 10^{-2}$ mol dm$^{-3}$, for $4 \times 10^{-4}$ mol dm$^{-3}$ Au$^{III}$, $7.2 \times 10^{-4}$ mol dm$^{-3}$ ascorbic acid, $6 \times 10^{-5}$ mol dm$^{-3}$ Ag$^+$, 0.2 mol dm$^{-3}$ 2-propanol and absorption dose of 56.6 Gy

5.25 Absorption spectra of gold nanoparticle solutions. pH effect: pH = (a) 3.24 (natural pH of the solution), (b) 2.58, (c) 2.33, (c) 2.01 and (d) 1.56, for $4 \times 10^{-4}$ mol dm$^{-3}$ Au$^{III}$, $7.2 \times 10^{-4}$ mol dm$^{-3}$ ascorbic acid, 0.1 mol dm$^{-3}$ CTAB, $6 \times 10^{-5}$ mol dm$^{-3}$ Ag$^+$, 0.2 mol dm$^{-3}$ isopropanol and
absorption dose of 56.6 Gy

6.1 Absorption spectra of aqueous Au nanoparticle solution obtained at radiation dose (a) unirradiated reaction mixture, (b) 0.5 kGy, (c) 0.9 kGy, (d) 1.3 kGy, (e) 1.5 kGy, (f) 1.6 kGy, (g) 1.8 kGy at a dose rate 2.2 kGy h\(^{-1}\)

6.2 TEM image of Au nanoparticles prepared using PVP of molecular weight 3,60,000 Da

6.3 Absorption spectra of aqueous Au nanoparticle solution obtained (a) with acetone and (b) without acetone for 1.7 kGy of absorbed dose

6.4 Absorption spectra of aqueous Au nanoparticle solution obtained for Ag\(^+\) concentration (a) 0, (b) 6 \(\times\) 10\(^{-5}\), (c) 1 \(\times\) 10\(^{-4}\), (d) 1.5 \(\times\) 10\(^{-4}\), (e) 2 \(\times\) 10\(^{-4}\), (f) 3 \(\times\) 10\(^{-4}\), (g) 4 \(\times\) 10\(^{-4}\) mol dm\(^{-3}\) for 1.7 kGy of absorbed dose

6.5 Absorption spectra of aqueous Au nanoparticle solution obtained for PVP concentration (a) 0.1\%, (b) 0.5\%, (c) 1\%, (d) 2\% for 1.7 kGy of absorbed dose

6.6 Absorption spectra of aqueous Au nanoparticle solution obtained for Au\(^{III}\) concentration (a) 1 \(\times\) 10\(^{-4}\), (b) 2.5 \(\times\) 10\(^{-4}\), (c) 4 \(\times\) 10\(^{-4}\), (d) 8 \(\times\) 10\(^{-4}\), (e) 1 \(\times\) 10\(^{-3}\) mol dm\(^{-3}\) for absorbed dose of 0.4, 0.9, 1.5, 3.0 and 3.5 kGy respectively

6.7 Absorption spectra of aqueous Au nanoparticle solution obtained for PVP of molecular weight (\(M_w\)) (a) 40,000 Da, (b) 1,60,000 Da, (c) 3,60,000 Da for 1.7 kGy of absorbed dose

6.8 Enzymatic oxidation of o-PDA with H\(_2\)O\(_2\)

6.9 Absorption spectra of reaction medium containing OPD, HRP, H\(_2\)O\(_2\) and Au nanoparticles (in PVP, \(M_w = 3,60,000\) Da) in citrate buffer with varying H\(_2\)O\(_2\) concentration (higher range of H\(_2\)O\(_2\) concentration) (a) 0, (b) 2.5 \(\times\) 10\(^{-6}\), (c) 5 \(\times\) 10\(^{-6}\), (d) 1 \(\times\) 10\(^{-5}\), (e) 2.5 \(\times\) 10\(^{-5}\), (f) 5 \(\times\) 10\(^{-5}\), (g) 7.5 \(\times\) 10\(^{-5}\), (h) 1 \(\times\) 10\(^{-4}\), (i) 1.3 \(\times\) 10\(^{-4}\), (j) 1.6 \(\times\) 10\(^{-4}\), (k) 2 \(\times\) 10\(^{-4}\) mol dm\(^{-3}\)

Inset: Linear plot of absorbance at 427 nm vs H\(_2\)O\(_2\) concentration incase Au nanoparticle used was in PVP of molecular weight (a)
Absorption spectra of reaction medium containing OPD, HRP, H$_2$O$_2$ and Au nanoparticles (in PVP, $M_w = 3,60,000$) in citrate buffer with varying H$_2$O$_2$ concentration (lower range of H$_2$O$_2$ concentration) (a) 0, (b) 1 x $10^{-7}$, (c) 3 x $10^{-7}$, (d) 6 x $10^{-7}$, (e) 1.2 x $10^{-6}$, (f) 1.8 x $10^{-6}$, (g) 2.5 x $10^{-6}$, (h) 3 x $10^{-6}$, (i) 5 x $10^{-6}$ mol dm$^{-3}$

Inset: Linear plot of absorbance at 427 nm vs H$_2$O$_2$ concentration incase Au nanoparticle used was in PVP of $M_w = 3,60,000$ Da(R=0.9954):H$_2$O$_2$ concentration range= 1 x $10^{-7}$ to 3 x $10^{-6}$ mol dm$^{-3}$
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# LIST OF ABBREVIATIONS

Abbreviations

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<td>AA</td>
<td>Ascorbic acid</td>
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<tr>
<td>Ag</td>
<td>Silver</td>
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<td>ATR</td>
<td>Attenuated total reflection</td>
</tr>
<tr>
<td>Au</td>
<td>Gold</td>
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<tr>
<td>CTAB</td>
<td>Cetyl trimethyl ammonium bromide</td>
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