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RESEARCH ARTICLE

The formation and catalytic activity of silver nanoparticles in aqueous polyacrylate solutions

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Supplementary Material

Polyacrylate Solutions

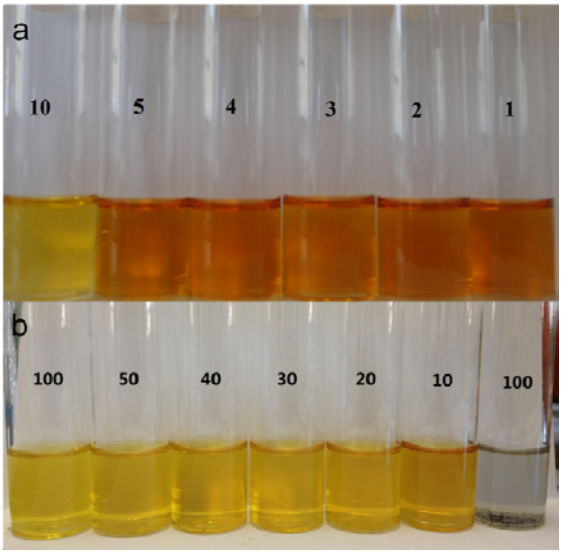

Fig. S1 Color variation one day after preparation of samples in which the $[NaBH_4]/[AgNO_3]$ ratio used in the preparation, and corresponding to the sample number, varied: (a) from 1 to 10 and (b) from 100 to 10 as indicated on each sample tube. The $[AgNO_3]$ was constant at 2.0×10^{-4} mol·L^{-1}. The sample numbered 100 at the far left of row b) contained no polyacrylate and shows the precipitated AgNP

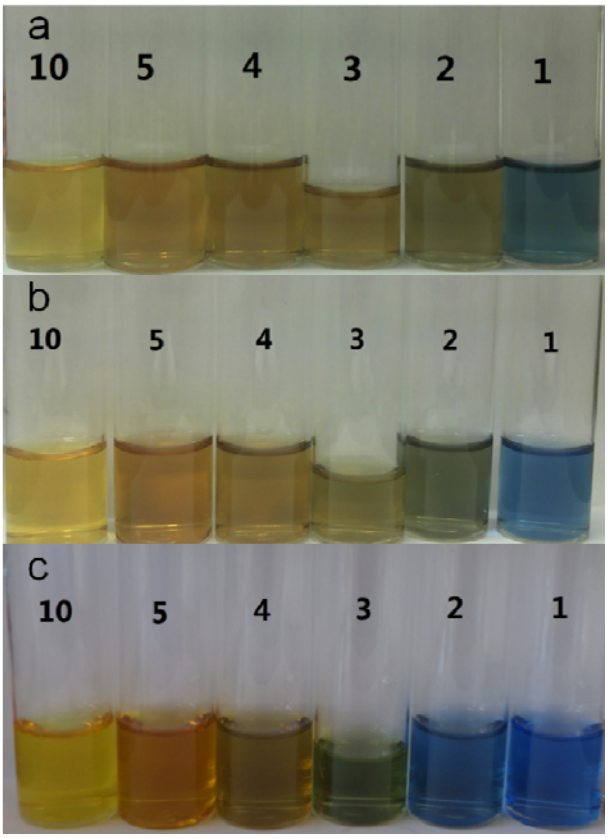

Fig. S2 Color variation: (a) 7 days, (b) 12 days and (c) 27 days after preparation of samples in which the $[NaBH_4]/[AgNO_3]$ ratio ranged from 1 to 10 as indicated on each sample tube and where $[AgNO_3]$ was constant at 2.0×10^{-4} mol·L^{-1}.

UV-vis Spectra

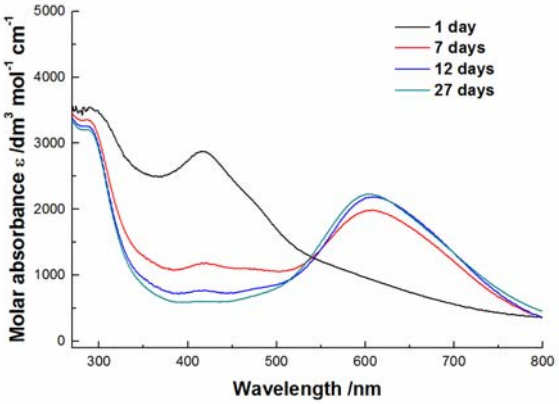

Fig. S3 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 1$

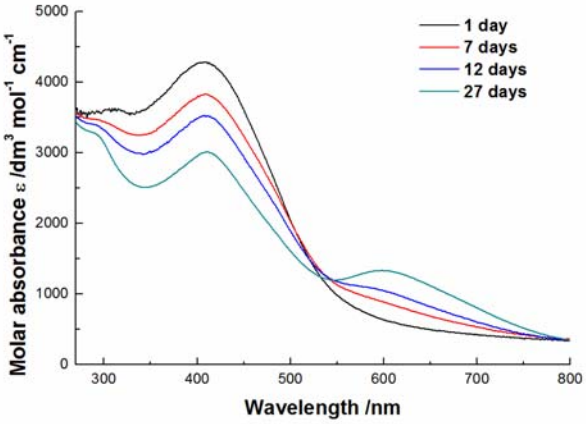

Fig. S4 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 3$

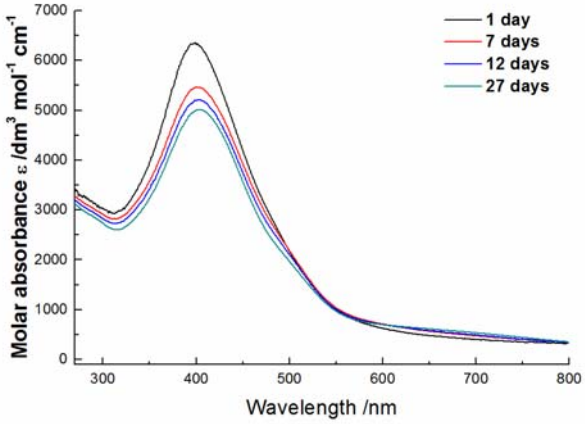

Fig. S5 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 5$

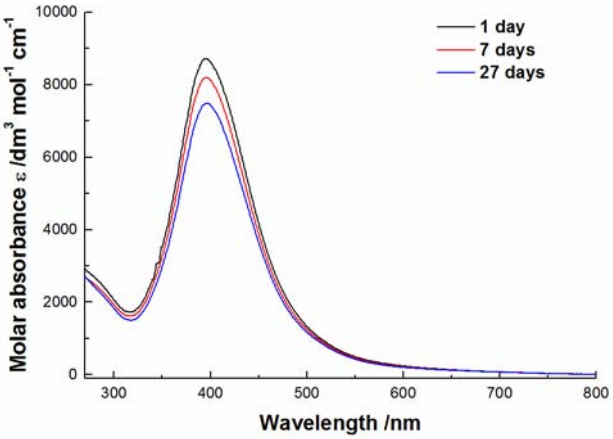

Fig. S6 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 10$

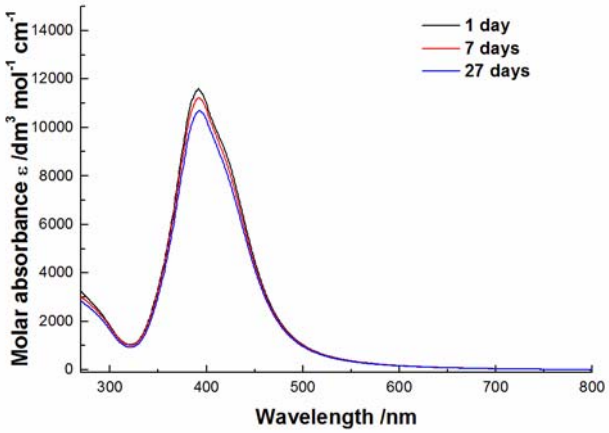

Fig. S7 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 20$

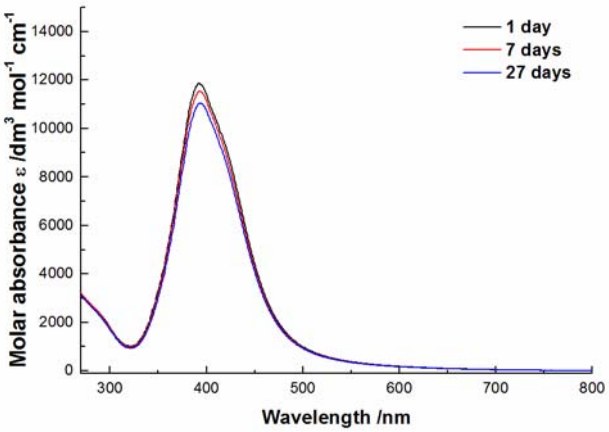

Fig. S8 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 30$

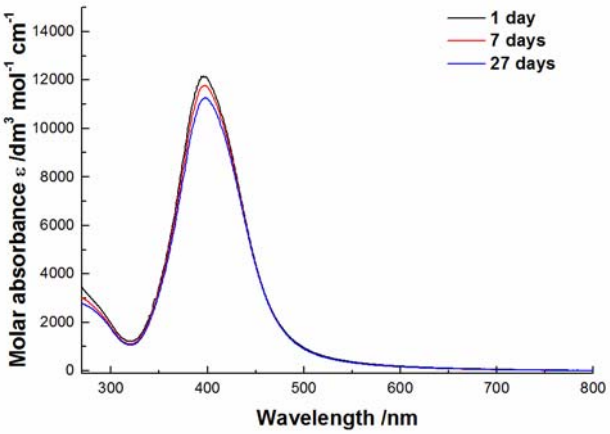

Fig. S9 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 40$

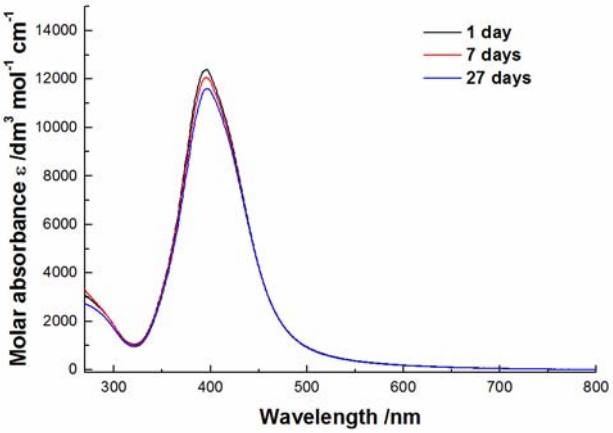

Fig. S10 Time dependence of the UV-vis spectrum of a AgNP sample prepared with $[NaBH_4]/[AgNO_3] = 50$

4-Nitrophenol Reduction Kinetic Data

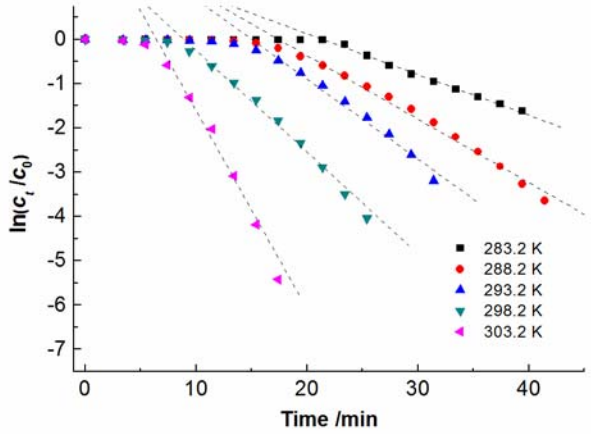

Fig. S11 Variation of induction time and ln(c_t/c_0) with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 1 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

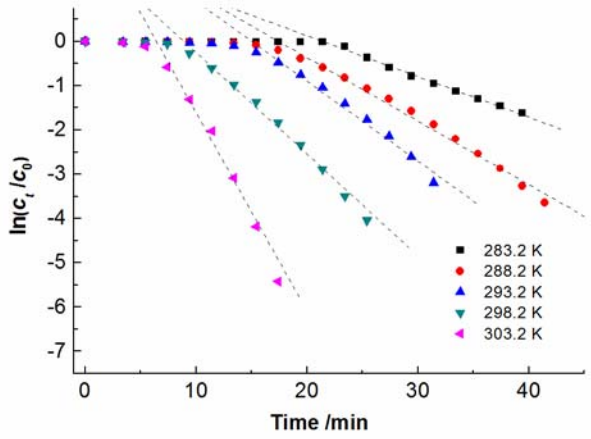

Fig. S12 Variation of induction time and ln(c_t/c_0) with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 2 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

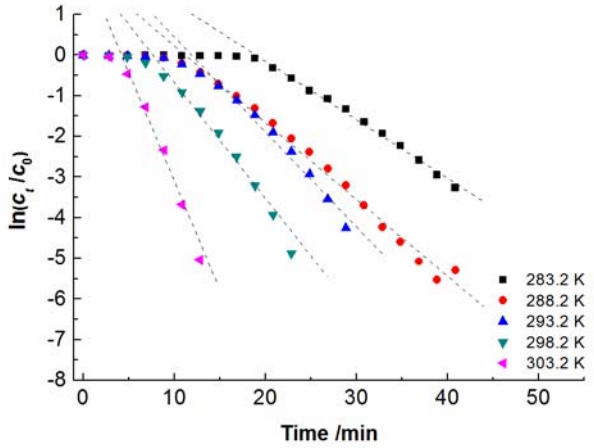

Fig. S13 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with $[NaBH_4]/[AgNO_3]$ = 3 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

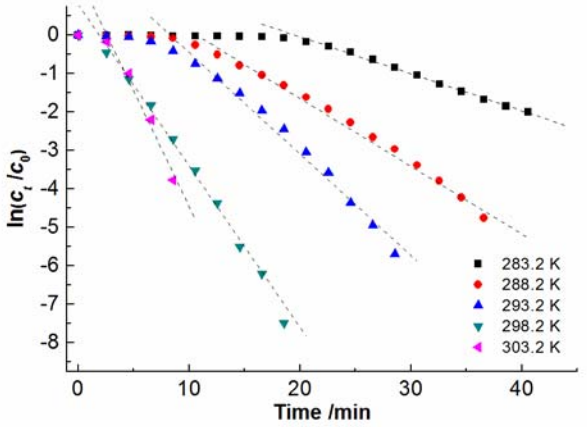

Fig. S14 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with $[NaBH_4]/[AgNO_3]$ = 4 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

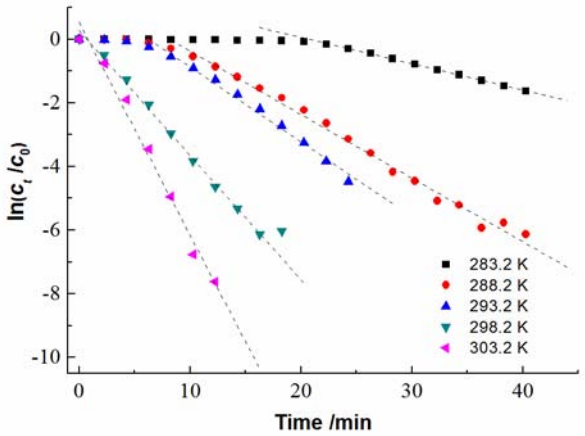

Fig. S15 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 5 and where [AgNP] = 2.0×10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39×10^{-5} and 1.08×10^{-3} mol·L^{-1}, respectively.

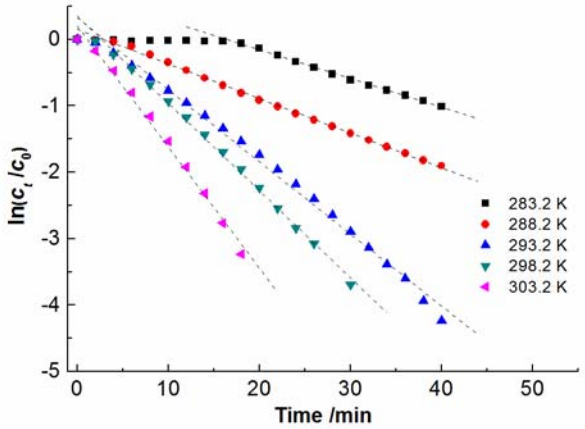

Fig. S16 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 10 and where [AgNP] = 2.0×10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39×10^{-5} and 1.08×10^{-3} mol·L^{-1}, respectively.

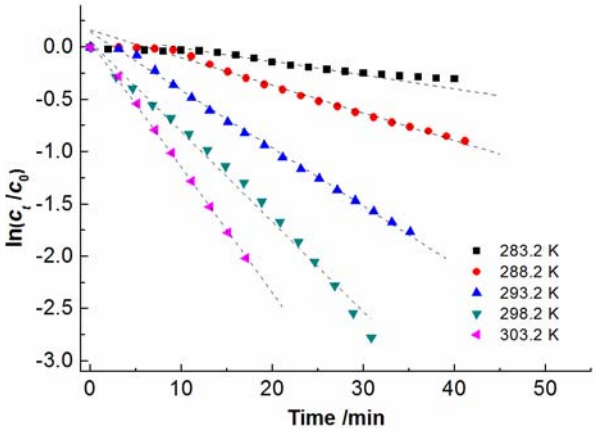

Fig. S17 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 20 and where [AgNP] = 2.0×10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39×10^{-5} and 1.08×10^{-3} mol·L^{-1}, respectively.

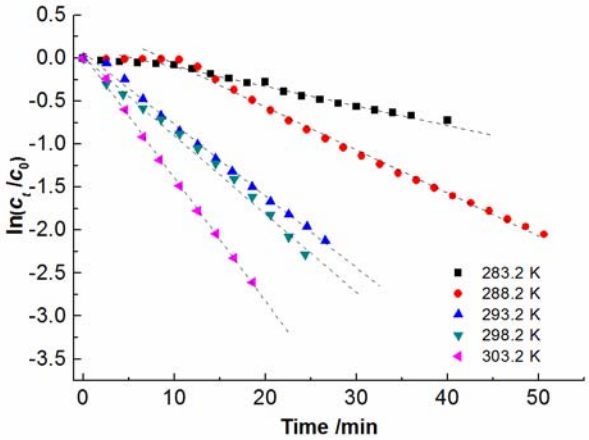

Fig. S18 Variation of induction time and $\ln(c_t/c_0)$ with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 40 and where [AgNP] = 2.0×10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39×10^{-5} and 1.08×10^{-3} mol·L^{-1}, respectively.

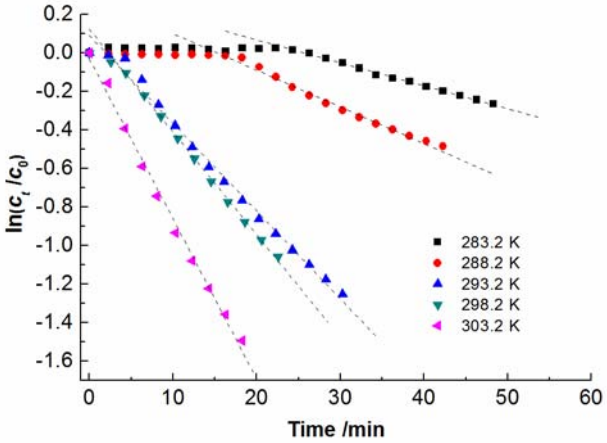

Fig. S19 Variation of induction time and ln(c_t/c_0) with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time t and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 50 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

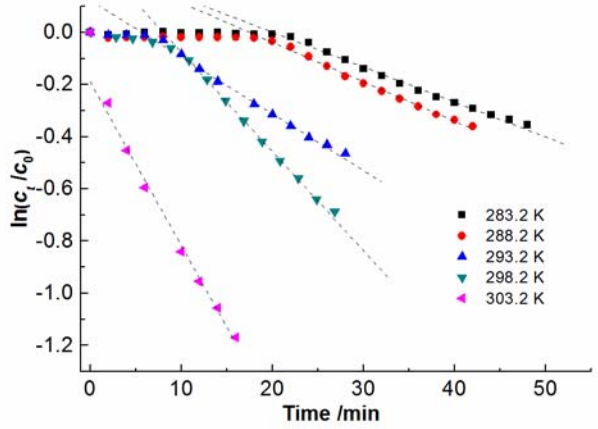

Fig. S20 Variation of induction time and ln(c_t/c_0) with time at five temperatures where c_t and c_0 are [4-NP] mol·L^{-1} at a time *t* and at time zero, respectively, for solutions where the AgNP were prepared with [$NaBH_4$]/[$AgNO_3$] = 100 and where [AgNP] = 2.0 × 10^{-7} mol·L^{-1} after dilution. The initial concentrations of 4-nitrophenol and $NaBH_4$, were 5.39 × 10^{-5} and 1.08 × 10^{-3} mol·L^{-1}, respectively.

Table S1 Experimental pseudo-first order rate constants derived from the time dependence of experimental absorbance data at 400 nm for individual kinetic runs.

Solution[a)]	Experimental rate constants[b] and temperatures[b)]				
$[NaBH_4]/[AgNO_3]$	$10^4\ k_{283.2}$ /s^{-1}	$10^4\ k_{288.2}$ /s^{-1}	$10^4\ k_{293.2}$ /s^{-1}	$10^4\ k_{298.2}$ /s^{-1}	$10^4\ k_{303.2}$ /s^{-1}
1	15.37 ± 0.10	23.90 ± 0.31	30.09 ± 0.56	38.25 ± 0.45	74.76 ± 1.12
2	14.65 ± 0.17	24.51 ± 0.29	29.28 ± 0.60	32.52 ± 0.43	79.75 ± 1.73
3	23.99 ± 0.13	31.52 ± 0.35	38.94 ± 0.86	47.46 ± 0.65	89.06 ± 1.57
4	16.02 ± 0.06	29.41 ± 0.43	44.05 ± 0.76	69.93 ± 0.34	100.2 ± 2.8
5	13.80 ± 0.01	33.29 ± 0.37	39.11 ± 0.50	65.21 ± 0.41	111.4 ± 3.1
10	7.233 ± 0.014	8.688 ± 0.010	18.10 ± 0.10	21.90 ± 0.07	30.41 ± 0.32
20	2.172 ± 0.044	4.402 ± 0.024	9.252 ± 0.02	14.36 ± 0.17	20.05 ± 0.03
30	4.020 ± 0.020	4.843 ± 0.029	7.122 ± 0.065	10.53 ± 0.04	17.39 ± 0.07
40	3.802 ± 0.030	8.358 ± 0.037	13.91 ± 0.04	15.21 ± 0.21	23.94 ± 0.04
50	1.983 ± 0.007	3.173 ± 0.034	7.597 ± 0.049	8.897 ± 0.011	13.85 ± 0.10
100	2.230 ± 0.018	2.527 ± 0.014	3.623 ± 0.014	6.347 ± 0.004	10.45 ± 0.08

a) The $[NaBH_4]/[AgNO_3]$ used in the preparation of the AgNP solutions which were diluted 1000-fold in the kinetic runs; b) Pseudo-first order rate constants derived from decrease in absorbance at 400 nm with time. The errors shown are for the fit of a first order rate law to $\ln(c_t/c_0)$. Experimental error is expected to be ~ 5%.