Article:
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Figure captions

FIG. 1. A schematic of gas bubbles of different sizes undergoing disproportionation while also gathering nanoparticle. The particle surface coverage of bubbles increases as a result of their shrinkage, as well as the arrival of new particles over time. When the coverage reaches a critical value, sufficient to produce a network of particle that can withstand the excess Laplace pressure, the bubble stops shrinking. The number density of particles in the dispersion available for adsorption drops over time. This particularly affects the final size of the larger bubbles which tend to stabilise later on.

FIG. 2. Increase in the particle surface coverage with time for three bubbles with initial radii of 5 μm (dashed-dotted line), 15 μm (dashed line) and 50 μm (solid line). The particle bulk volume fraction was 0.04 %.

FIG. 3. The fraction of gas retained, $(R_f/R(0))^3$, plotted as a function of the initial radius of the bubbles, R(0), in a system with a large excess of stabilising nanoparticles. The inset shows the same data but now plotted as $R_f/R(0)$ versus the initial radius, to aid comparison with Fig. 4.

FIG. 4. Graphs showing the final size ratio, $(R_f/R(0))$, plotted vs. β (the ratio of the maximum specific area that can be stabilised by the particles to the specific initial air-water interface). The curves are for highly monodispersed bubble distributions with initial bubble radii of 50 μm (solid line), 75 μm (short dashed line), 100 μm (long dashed line) and 120 μm (dashed-dotted line). The dotted line represents the final size ratio calculated assuming that all the particles are instantaneously placed on the surface of the bubbles from the onset.

FIG. 5. Fraction of the retained gas, shown as a function of the bubble radius, for highly monodispersed bubble dispersions with an initial gas volume fraction of 25 %. The bulk volume fraction of the nanoparticles was 0.04 % (solid line) and 0.004 % (dashed line).

FIG. 6. The bubble size distribution function at different times t = 0 (dotted line), t = 4.3 min (short dashed line), t = 8.6 min (dashed-dotted line), t = 12.9 min (long dashed line) and t = 34.5 min (solid line) when all bubbles are stable. The initial volume fraction of bubbles and that of nanoparticles were 10.7 % and 0.04 %, respectively.

FIG. 7. The value of particle surface coverage, λ, for bubbles of different sizes in the system of fig. 5, after a time t = 4.3 min (short dashed line), t = 8.6 min (dashed-dotted line) and t = 12.9 min (long dashed line).

FIG. 8. The decrease in the fraction of gas with time, displayed for three different bubble dispersions with $\beta = 0.25$ (solid line), $\beta = 1.0$ (dashed line) and $\beta = 5.0$ (dashed-dotted line).

FIG. 9. The final bubble size distributions for three systems containing the same number of nanoparticles, but different initial volumes of gas. Each line corresponds to the same system as that in fig. 7. The initial bubble size distribution for all three cases is also shown by the dotted line for comparison. The inset shows the graph for the $\beta = 0.25$ case in more detail.

Figure 1

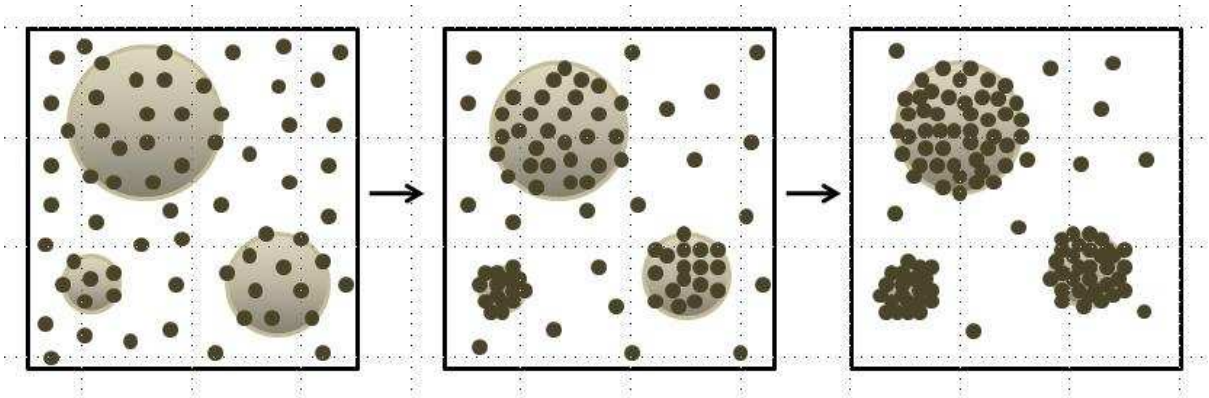


Figure 2

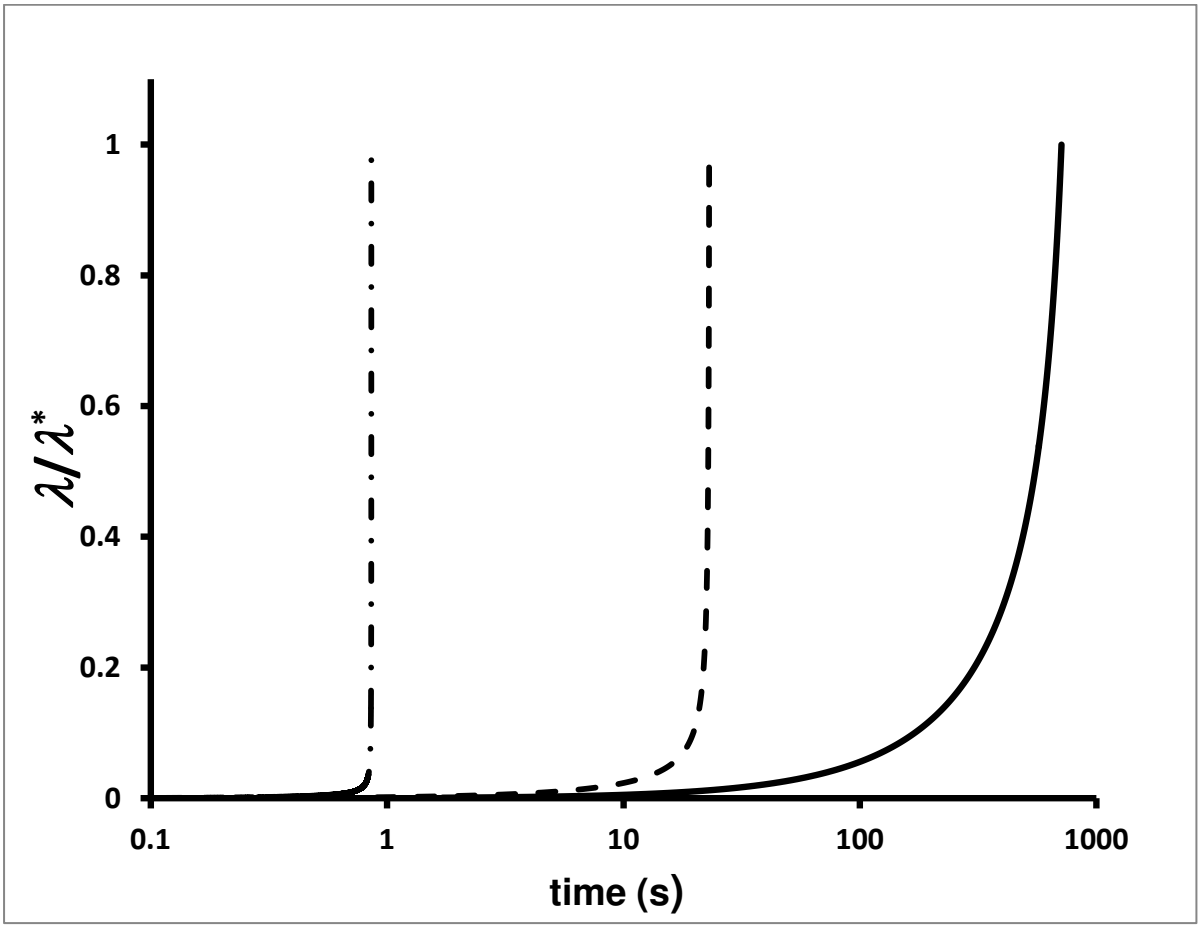


Figure 3

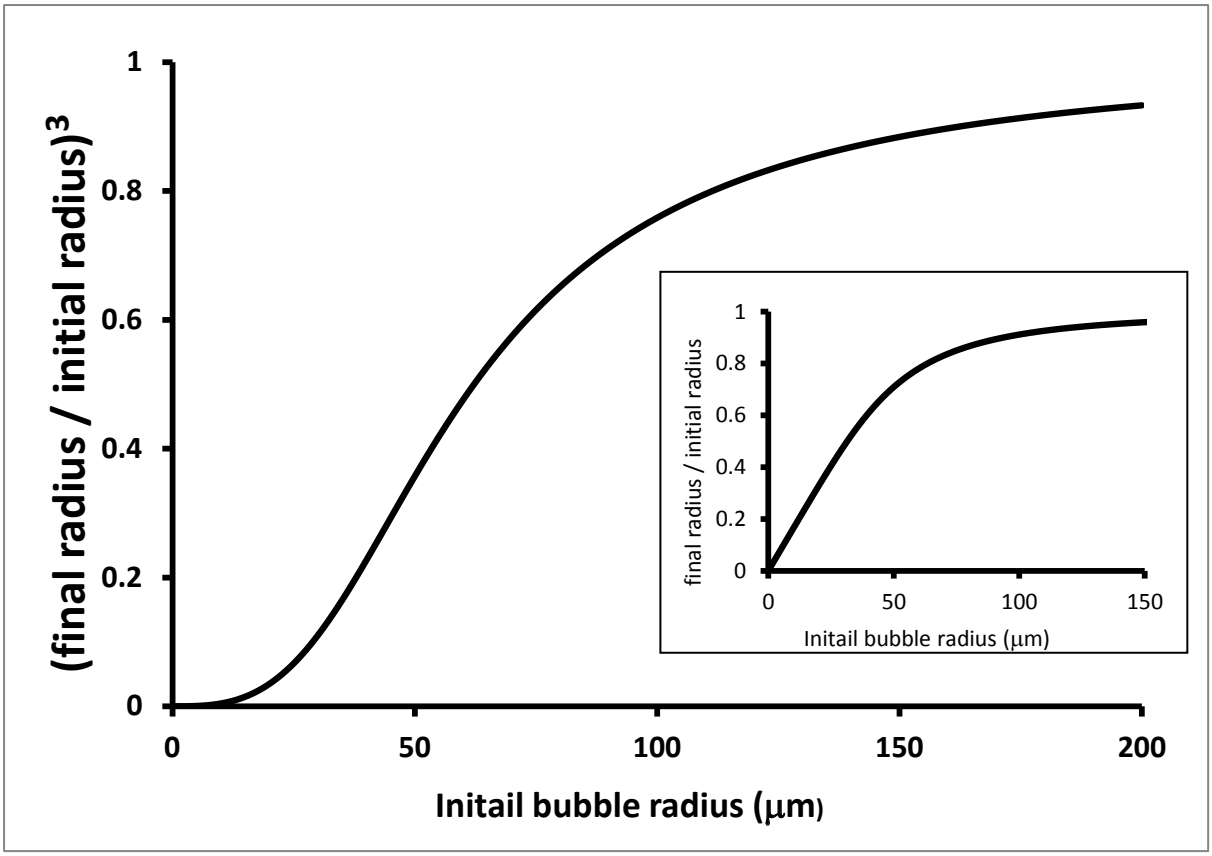

(final radius / initial radius)3
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
Initail bubble radius (μm)
final radius / initial radius
1
0.8
0.6
0.4
0.2
0
0
50
100
150
Initail bubble radius (μm)

Figure 4

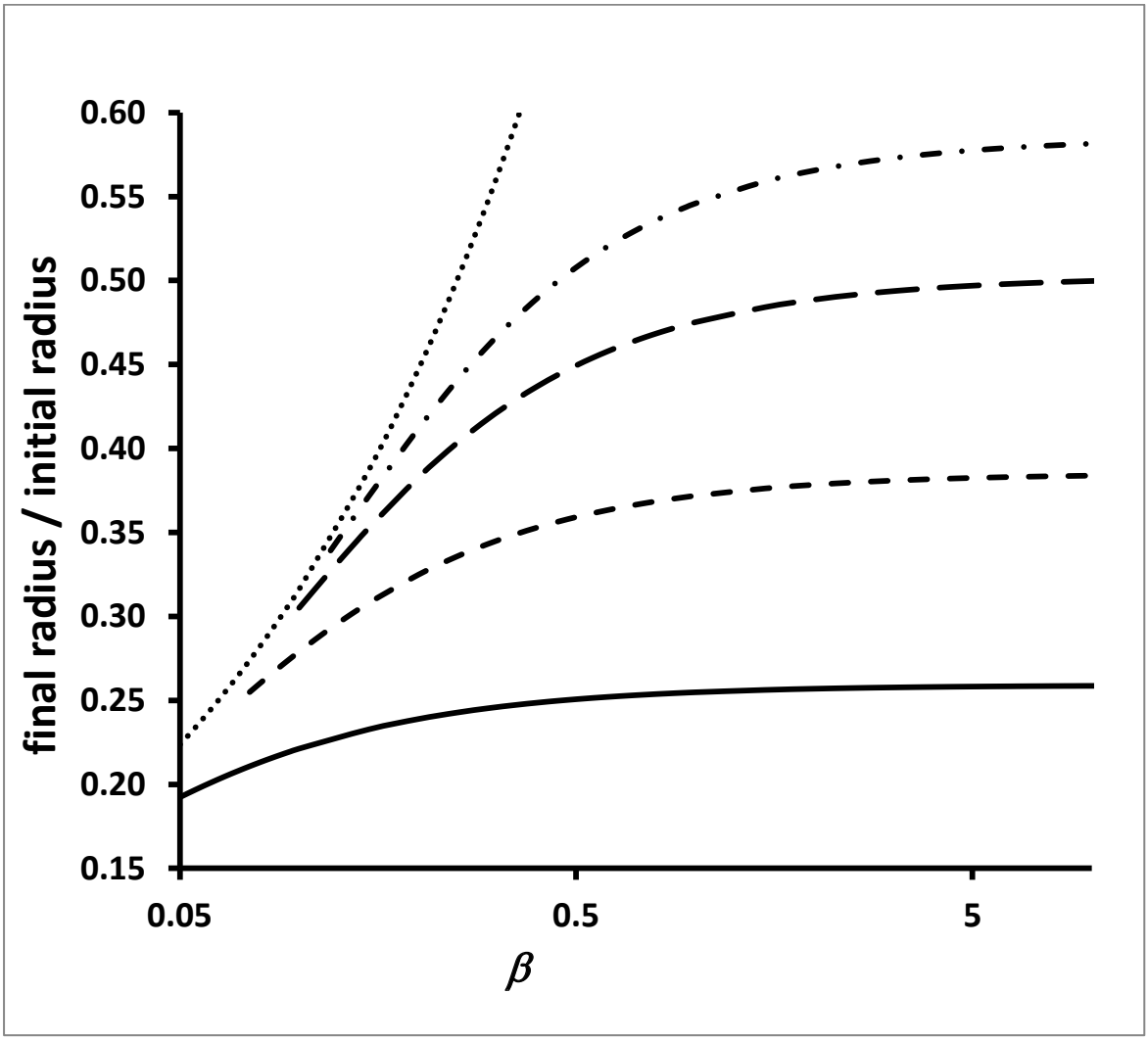

0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
final radius / initial radius
0.05
0.5
5
β

Figure 5

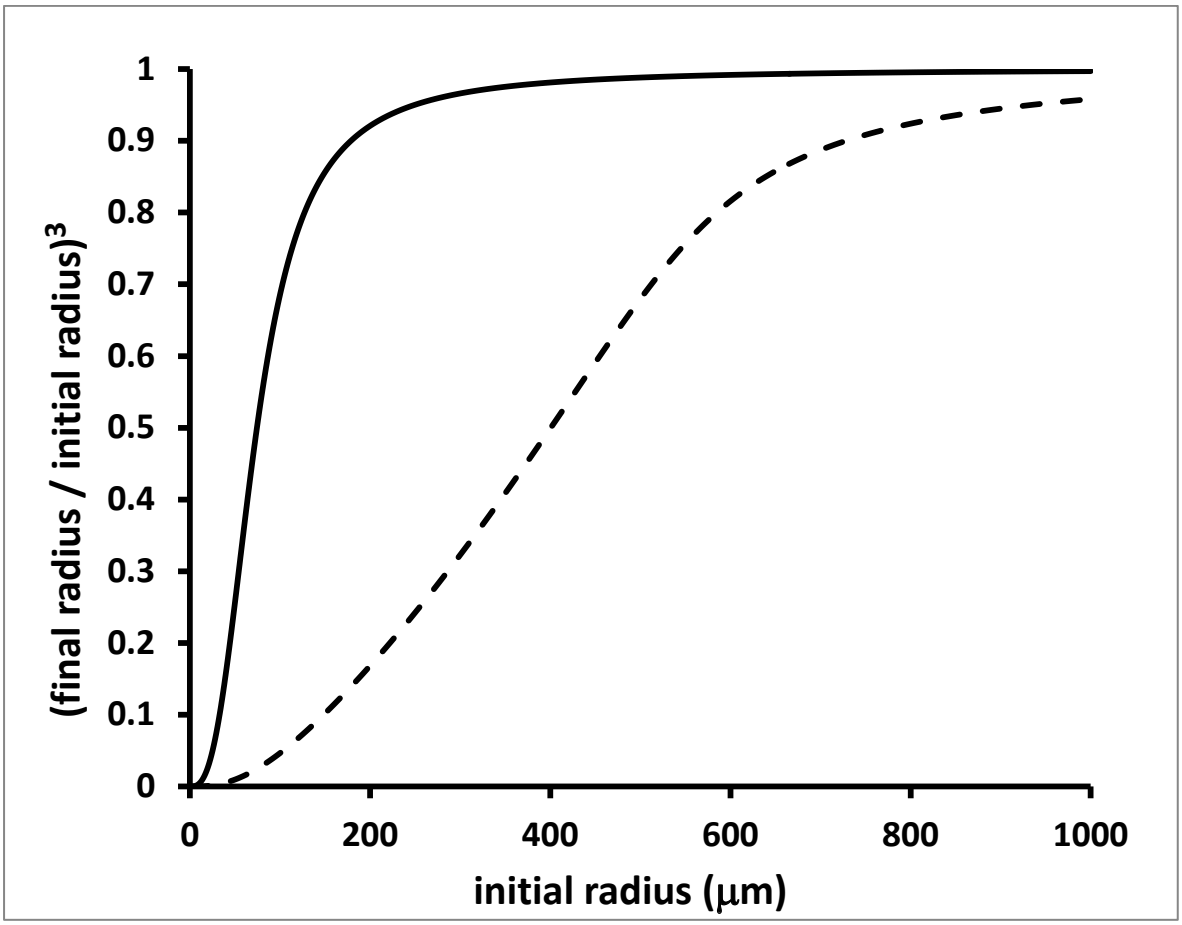

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
(final radius / initial radius)³
0
200
400
600
800
1000
initial radius (μm)

Figure 6

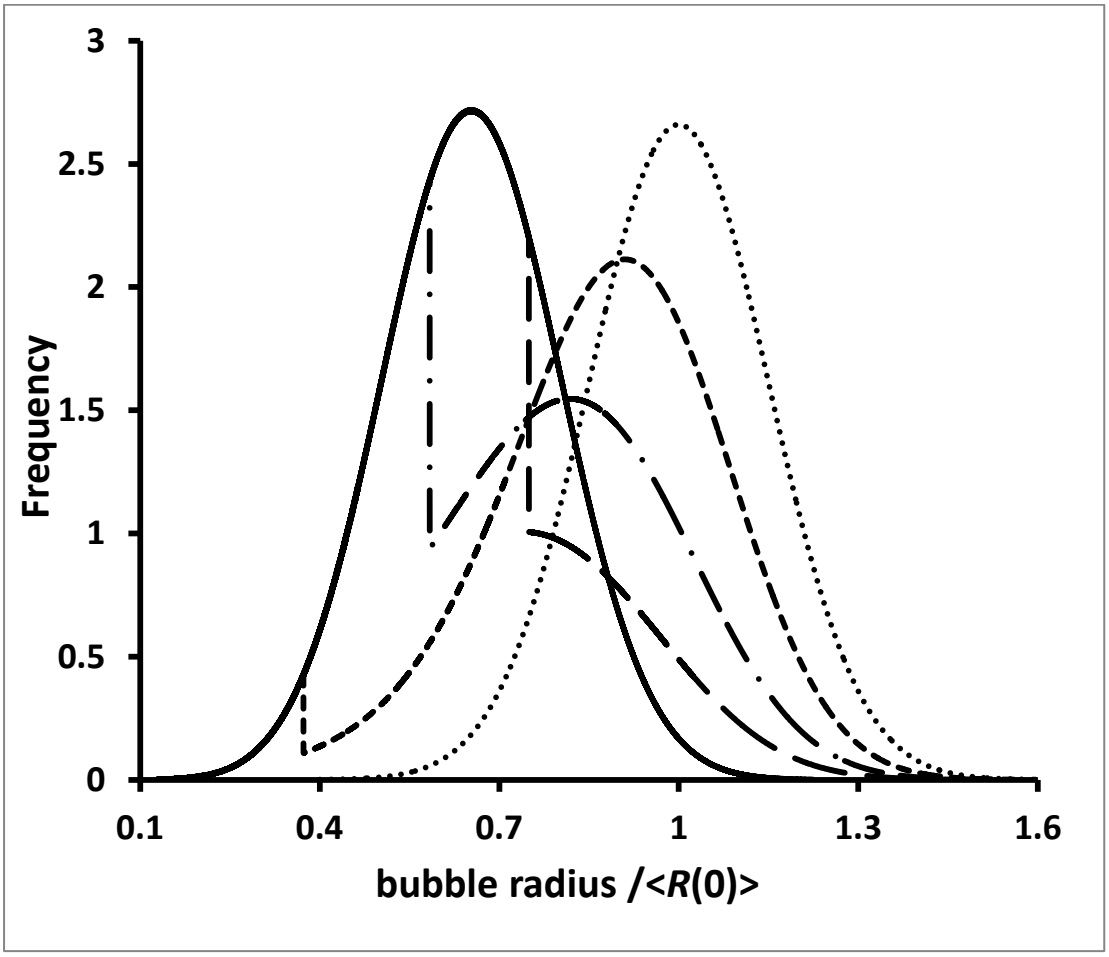


Figure 7

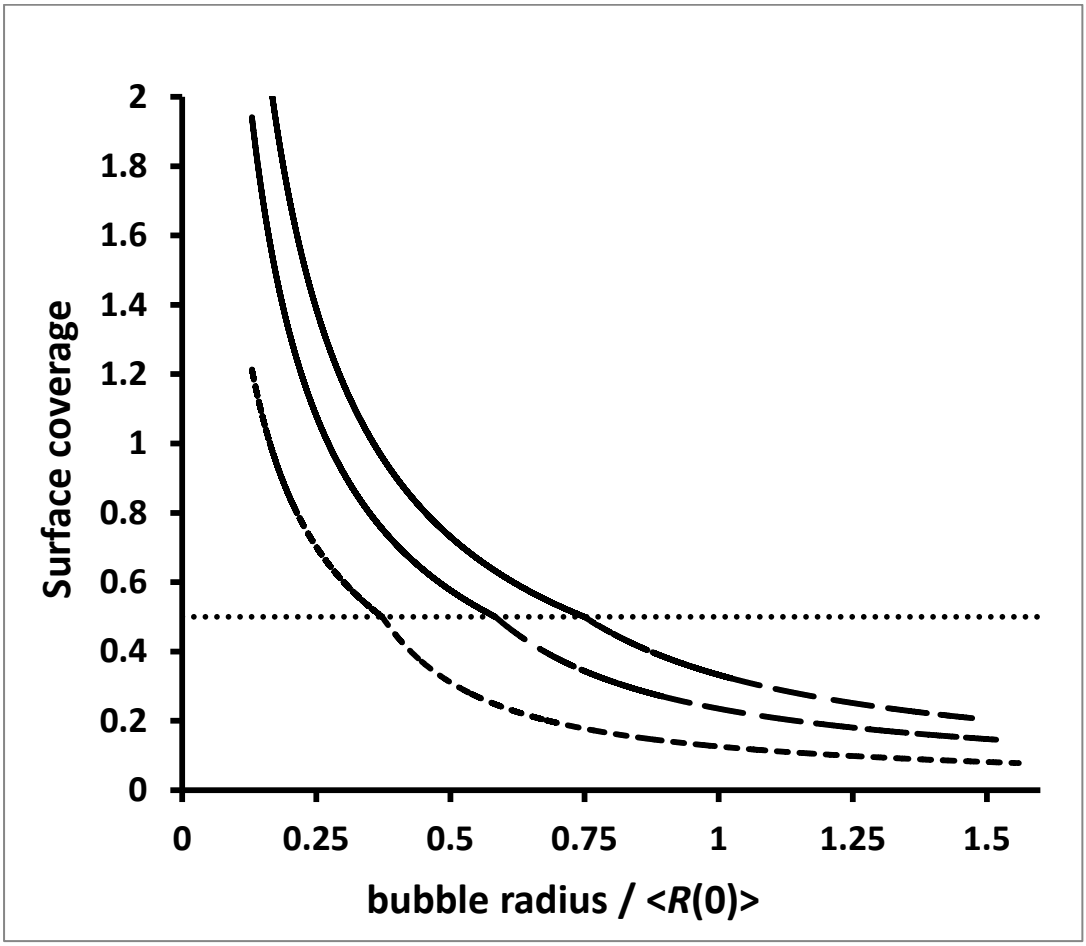

Surface coverage
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.25
0.5
0.75
1
1.25
1.5
bubble radius / <R(0)>

Figure 8

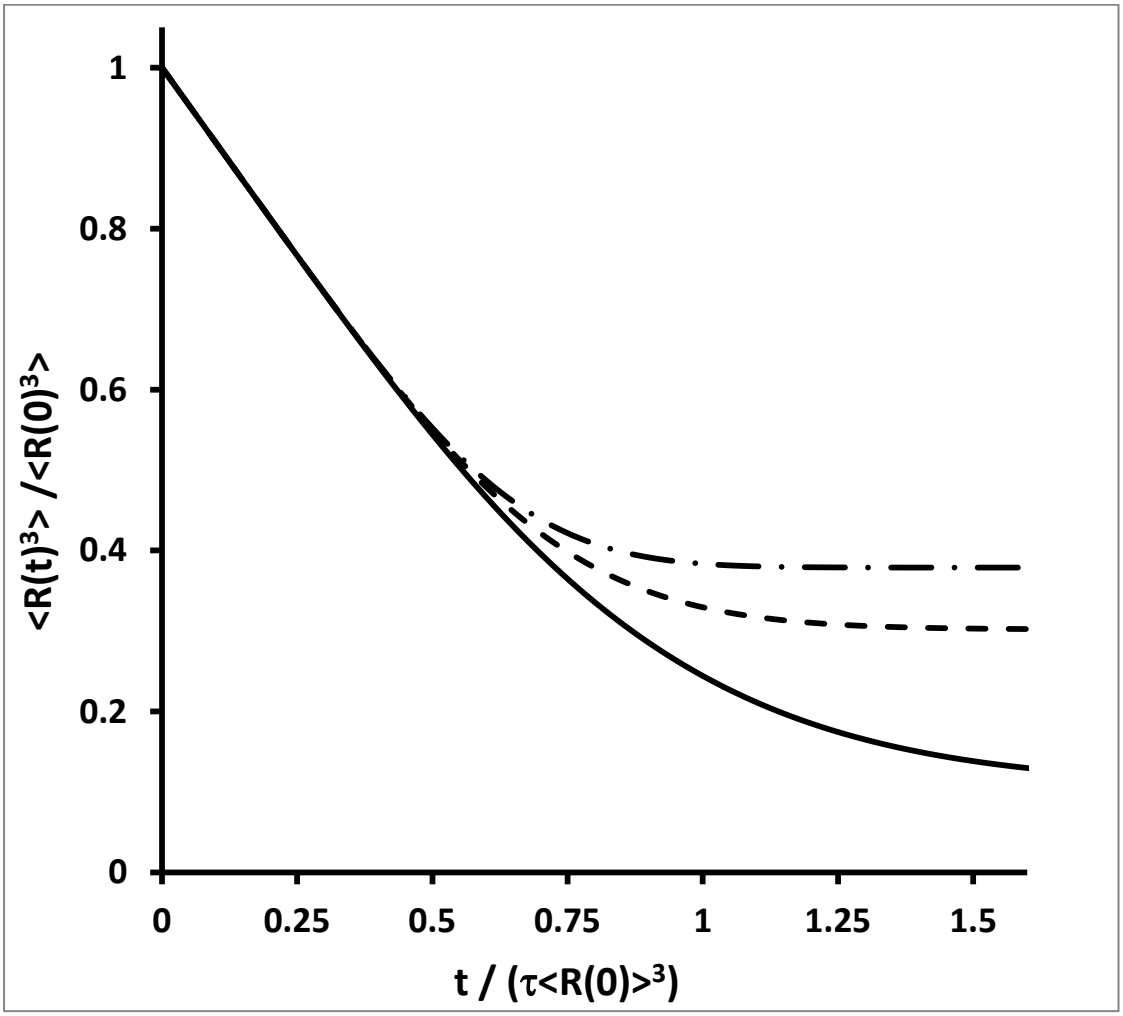
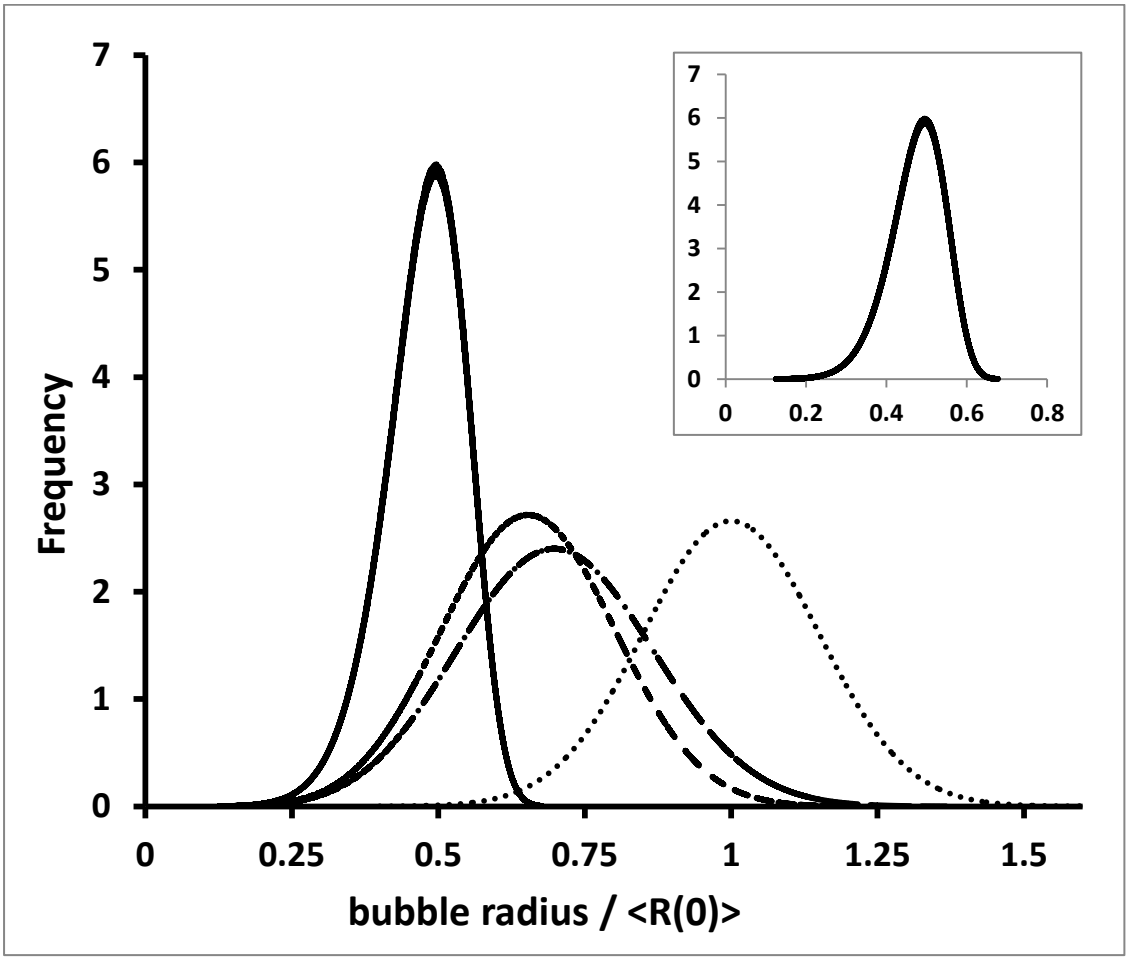


Figure 9


Frequency
bubble radius / <R(0)>
0
0.25
0.5
0.75
1
1.25
1.5
0
1
2
3
4
5
6
7
0
0.2
0.4
0.6
0.8