niques on the demonstrated bench-top scale is, for a 1257 Rad/s, 96 h separation, assuming no recovery of the density medium, approximately $7.50 per mg of SWCNTs separated. The cost is primarily associated with the differential rotor cost of approximately $17,000/100 separations per rotor, which is approximately $17 per separation; and for the density gradient medium, approximately $23.50 per separation, generating 6 to 10 mg of separated SWCNTs. The SWCNT cost approximately $1/mg after dispersion and centrifugation to remove amorphous impurities, the cost of the surfactant approximately $1.50 per separation and the cost of electricity are relatively marginal factors. Recovery of the density medium, and shorter separations times dramatically reduce the projected marginal cost. For size exclusion chromatography in contrast, the current necessity of using custom made small number oligimer single-stranded DNA to achieve an acceptably robust dispersion introduces an approximate cost of $15 to $20 per mg of dispersed SWCNT, prior to even the length separation, solely due to the DNA.

[0129] Centrifugation can be used to separate single wall carbon nanotubes by length. Separation improves with a reduced rate of separation, however the exact cause of this improvement is unclear. Length for separated fractions measured using AFM, DLS, and UV-Vis-NIR extrapolation were found to be in consistent agreement. Longer SWCNTs are found to have stronger optical transitions consistent with previous results. These long SWCNT display excellent optical properties. Length separation by this method is relatively facile compared to previous techniques, and is estimated at bench scale to cost less than $4/mg of separated SWCNTs given (the facile) recovery of the density inducing polymer.

[0130] Many other benefits will no doubt become apparent from future application and development of this technology.

[0131] All patents, published patent applications, and articles referred to herein are hereby incorporated by reference in their entirety.

[0132] As described hereinabove, the present invention solves many problems associated with previous type devices. However, it will be appreciated that various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art without departing from the principle and scope of the invention, as expressed in the appended claims.

What is claimed is:

1. A method for separating carbon nanotubes by length, the method comprising:
- providing carbon nanotubes having different lengths;
- dispersing the carbon nanotubes in a suitable medium to solubilize the nanotubes and thereby form a first liquid;
- preparing a second liquid having an appropriate density with respect to the solubilized nanotubes;
- forming an array of liquid layers in a vessel including a first layer comprising the first liquid and a second layer disposed above the first layer, the second layer comprising the second liquid;
- centrifuging the vessel and array of layers for a time period sufficient for at least a portion of the nanotubes in the first layer to migrate into the second layer and form a plurality of fractions in the second layer, wherein each fraction includes carbon nanotubes having an average length different than that of other fractions in the vessel.

2. The method of claim **1**, wherein the first liquid comprises water.

3. The method of claim **2**, wherein the first liquid further comprises surfactant.

4. The method of claim **1**, wherein dispersing includes an operation selected from the group consisting of (i) sonicating the medium and the carbon nanotubes, (ii) centrifuging the medium and the carbon nanotubes, and (iii) combinations of (i) and (ii).

5. The method of claim **1**, wherein the second layer comprises a density adjusting agent.

6. The method of claim **5**, wherein the density adjusting agent is 5,5'-[(2-hydroxy-1-3 propanediyl)-bis(acetylamino)]bis [N,N'-bis(2,3dihydroxylpropyl-2,4,6-triiodo-1,3-benzenecarboxamide]

7. The method of claim **5**, wherein the second layer further comprises a surfactant.

8. The method of claim **1** wherein the array of liquid layers further includes a third layer disposed below the first layer, the third layer having a density greater than that of the first layer.

9. A method for separating carbon nanotubes by length, the method comprising:
- obtaining carbon nanotubes having a range of different lengths;
- dispersing the carbon nanotubes in a first liquid to thereby form a dispersed sample of carbon nanotubes;
- selecting a second liquid having a density such that the difference between (i) the density of the second liquid and (ii) the average density of the carbon nanotubes in the dispersed sample, is greater than the difference between (ii) and (iii) the density of any species of carbon nanotubes in the dispersed sample;
- in a vessel adapted for centrifugation, forming a first layer comprising at least a portion of the dispersed sample and forming a second layer comprising at least a portion of the second liquid, wherein the second layer is disposed above the first layer;
- centrifuging the vessel and first and second layers for a time period sufficient for a plurality of fractions to form within the second layer, wherein each fraction includes carbon nanotubes having an average length different than that of other fractions in the vessel.

10. The method of claim **9**, wherein the first liquid comprises water.

11. The method of claim **10**, wherein the first liquid further comprises surfactant.

12. The method of claim **9**, wherein dispersing includes an operation selected from the group consisting of (i) sonicating the first liquid and the carbon nanotubes, (ii) centrifuging the first liquid and the carbon nanotubes, and (iii) combinations of (i) and (ii).

13. The method of claim **9**, wherein the second liquid comprises 5,5'-[(2-hydroxy-1-3 propanediyl)-bis(acetylamino)]bis [N,N'-bis(2,3dihydroxylpropyl-2,4,6-triiodo-1,3-benzenecarboxamide].

14. The method of claim **9**, wherein the second liquid comprises surfactant.

15. A method for separating carbon nanotubes by length, the method comprising:
- providing carbon nanotubes having different lengths;
- dispersing the carbon nanotubes in water to form an aqueous mixture of the nanotubes and water;
- forming a liquid having a density such that the difference between (i) the density of the liquid and (ii) the average density of the carbon nanotubes in the aqueous mixture,