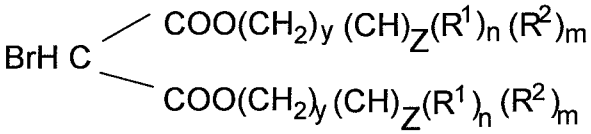
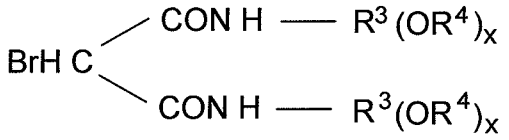
CLAIMS:

1. A method for reducing the friction of a lubricating oil comprising a base stock or base oil by dissolving in the base stock or base oil from 10 ppm to 10 wt% of a functionalized carbon nanostructure material which functionalized carbon nanostructure material is made by a process comprising: (1) suspending a carbon nanostructure material in a chlorinated benzene solvent; and (2) adding to the suspension of (1), in ~~multiple~~ at least 2 additions over a reaction time ranging from 2 days to 4 days between each addition, materials of the formula:



I

or

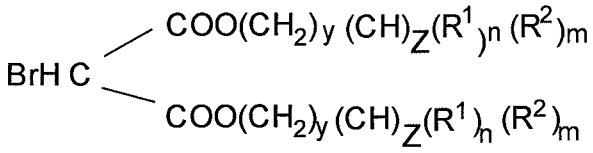


II

wherein R^1 and R^2 are the same or different hydrogen or C_1 to C_{18} alkyl groups provided at least one of R^1 and R^2 is not hydrogen, *y* is 0 to 10, Z is 0 or 1, *n* and *m* are integers ranging from 0 to 2 provided *n*+*m* is at least 1, R^3 is a C_1 to C_{15} alkyl or C_6 to C_{10} aryl group, R^4 is a C_2 to C_{14} alkyl group, C_6 to C_{10} aryl, C_1 to C_{10} alkylaryl or C_1 to C_{10} arylalkyl group, and *x* is an integer ranging from 0 to up to the replaceable valence of the R^3 group, and 1,8-diazabicyclo[5.4.0] undecene (DBU), wherein the resulting functionalized carbon nanostructure material has at least twice the level of functionalization as compared to functionalized carbon nanostructure material made using the same carbon nanostructure material and material of formula I or II and DBU when the materials of formula I or II and DBU are added to the carbon nanostructure material all at once in a single addition.

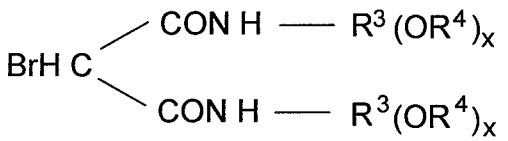
2. A method for reducing the friction of a lubricating oil comprising a base stock or base oil by dissolving in the base stock or base oil from 10 ppm to 10 wt% of a functionalized carbon nanostructure material which functionalized carbon nanostructure material is made by a process comprising: (1) suspending a carbon

nanostructure material in a chlorinated benzene solvent; and (2) adding to the suspension of (1), dropwise over a reaction time ranging from 2 days to 4 days at a rate of one drop every thirty seconds to thirty minutes, material of the formula:



I

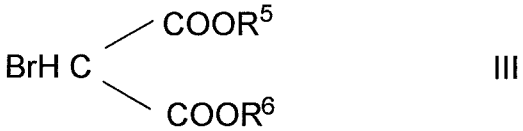
or



II

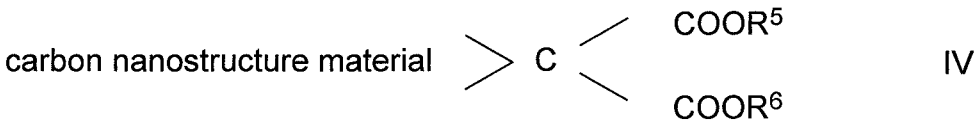
wherein R^1 and R^2 are the same or different hydrogen or C_1 to C_{18} alkyl groups provided at least one of R^1 and R^2 is not hydrogen, *y* is 0 to 10, Z is 0 or 1, *n* and *m* are integers ranging from 0 to 2 provided *n*+*m* is at least 1, R^3 is a C_1 to C_{15} alkyl or C_6 to C_{10} aryl group, R^4 is a C_2 to C_{14} alkyl group, C_6 to C_{10} aryl, C_1 to C_{10} alkylaryl or C_1 to C_{10} arylalkyl group, and *x* is an integer ranging from 0 to up to the replaceable valence of the R^3 group, and 1,8-diazabicyclo[5.4.0] undecene (DBU), wherein the resulting functionalized carbon nanostructure material has at least twice the level of functionalization as compared to functionalized carbon nanostructure material made using the same carbon nanostructure material and material of formula I or II and DBU when the materials of formula I or II and DBU are added to the carbon nanostructure material all at once in a single addition.

3. A method of reducing the friction of a lubricating oil comprising a base stock or base oil by dissolving in the base stock or base oil from 10 ppm to 10 wt% of a functionalized carbon nanostructure material which functionalized carbon nanostructure material is made by a process comprising: (1) suspending a carbon nanostructure material in a chlorinated benzene solvent; (2) adding of the suspension of (1), in ~~multiple~~ at least 2 additions over a reaction time ranging from 2 days to 4 days between each addition, material of the formula:



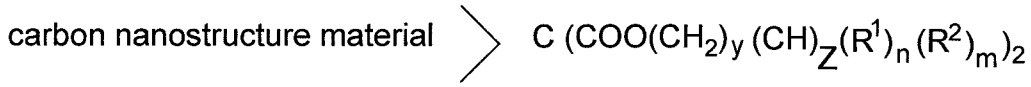
III

wherein R^5 and R^6 are the same or different and are selected from methyl, ethyl or propyl groups and DBU to yield a product of the formula:



IV

and (3) trans-esterifying or trans-amidating material of formula IV with an esterification or amidation agent of the type which when reacted with the material of formula IV results in the production of a functionalized carbon nanostructure material of the formula:



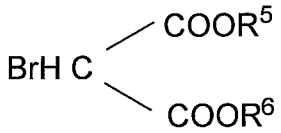
or



wherein R^1 and R^2 are the same or different hydrogen or C_1 to C_{18} alkyl groups provided at least one of R^1 and R^2 is not hydrogen, *y* is 0 to 10, preferably 0 to 5 and Z is 0 or 1, *n* and *m* are integers ranging from 0 to 2 provided *n*+*m* is at least 1, R^3 is a C_1 to C_{15} alkyl or C_6 to C_{10} aryl group, R^4 is a C_2 to C_{14} alkyl group, C_6 to C_{10} aryl, C_1 to C_{10} alkylaryl or C_1 to C_{10} arylalkyl group, and *x* is an integer ranging from 0 to up to the replaceable valence of the R^3 group, wherein the resulting functionalized carbon nanostructure material has at least twice the level of functionalization as compared to functionalized carbon nanostructure material made using the same carbon nanostructure material and material of formula III and DBU when the materials of formula III and DBU are added to the carbon nanostructure material all at once in a single addition.

4. A method for reducing the friction of a lubricating oil comprising a base stock or base oil by dissolving in the base stock or base oil from 10 ppm to 10 wt% of a functionalized carbon nanostructure material which functionalized carbon nanostructure material is made by a process comprising: (1) suspending a carbon nanostructure material in a chlorinated benzene solvent; (2) adding to the suspension

of (1), dropwise over a reaction time ranging from 2 days to 4 days at a rate of one drop every thirty seconds to thirty minutes, material of the formula:



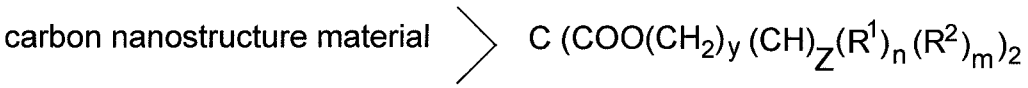
III

wherein R^5 and R^6 are the same or different and are selected from methyl, ethyl or propyl groups, and 1,8-diazabicyclo[5.4.0]undecene (DBU) to yield a product of the formula:



IV

and (3) trans-esterifying or trans-amidating the material of formula IV with an esterification or amidation agent of the type which when reacted with the material of formula IV results in the production of a functionalized carbon nanostructure material of the formula:



or



wherein R^1 and R^2 are the same or different hydrogen or C_1 to C_{18} alkyl groups provided at least one of R^1 and R^2 is not hydrogen, *y* is 0 to 10, preferably 0 to 5 and Z is 0 or 1, *n* and *m* are integers ranging from 0 to 2 provided *n*+*m* is at least 1, R^3 is a C_1 to C_{15} alkyl or C_6 to C_{10} aryl group, R^4 is a C_2 to C_{14} alkyl group, C_6 to C_{10} aryl, C_1 to C_{10} alkylaryl or C_1 to C_{10} arylalkyl group, and *x* is an integer ranging from 0 to up to the replaceable valence of the R^3 group, wherein the resulting functionalized carbon nanostructure material has at least twice the level of functionalization as compared to functionalized carbon nanostructure material made using the same carbon nanostructure material and material of formula III and DBU when the materials of formula III and DBU are added to the carbon nanostructure material all at once in a single addition.

5. The method of claim 1 wherein the carbon nanostructure material is single-walled carbon nanotubes.

6. The method of claim 5 wherein the single-walled carbon nanotubes are short single-walled nanotubes having a length between 1 to 10 microns and a diameter between 0.01 to 50 nanometers.

7. The method of claim 2 wherein the carbon nanostructure material is single-walled carbon nanotubes.

8. The method of claim 7 wherein the single-walled carbon nanotubes are short single-walled carbon nanotubes having a length between 1 to 10 microns and a diameter between 0.01 to 50 nanometers.

9. The method of claim 3 wherein the carbon nanostructure material is single-walled carbon nanotubes.

10. The method of claim 9 wherein the single-walled carbon nanotubes are short single-walled carbon nanotubes having a length between 1 to 10 microns and a diameter between 0.01 to 50 nanometers.

11. The method of claim 4 wherein the carbon nanostructure material is single-walled carbon nanotubes.

12. The method of claim 11 wherein the single-walled carbon nanotubes are short single-walled carbon nanotubes having a length between 1 to 10 microns and a diameter between 0.01 to 50 nanometers.

13. The method of claim 1, 5 or 6 wherein the carbon nanostructure material has had its surface decarboxylated.

14. The method of claim 2, 7 or 8 wherein the carbon nanostructure material has had its surface decarboxylated.

15. The method of claim 3, 9 or 10 wherein the carbon nanostructure material has had its surface decarboxylated.

16. The method of claim 4, 11 or 12 wherein the carbon nanostructure material has had its surface decarboxylated.

~~17. The method of claim 1 wherein the suspended carbon nanostructure material is mixed with quantities of materials of formula I or II and DBU at least twice with interval between the additions sufficient for reaction to occur between the suspended carbon nanostructure material and the material of formula I or II and DBU.~~

~~18. The method of claim 17 wherein the interval between additions is at least six hours.~~

~~19. The method of claim 2 wherein the addition of material of formula I or II and DBU to the suspended carbon nanostructure material dropwise over a period of at least two days at a rate of one drop every thirty seconds to thirty minutes.~~

~~20. The method of claim 3 wherein the suspended carbon nanostructure material is mixed with quantities of material of formula III and DBU at least twice with interval between the additions sufficient for reaction to occur between the suspended carbon nanostructure material and the material of formula III and DBU.~~

~~21. The method of claim 20 wherein the interval between additions is at least six hours.~~

~~22. The method of claim 4 wherein the addition of material of formula III and DBU to the suspended carbon nanostructure material is dropwise over a period of at least two days at a rate of one drop every thirty seconds to thirty minutes.~~

~~23.~~17. The method of claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11~~,~~ or 12~~, 17, 18, 19, 20, 21 or 22~~ wherein the temperature is held at from 40 to 70°C during the addition step and for one to four days following the final addition of the material to the suspended carbon nanostructure materials.

~~24.~~18. The method of claim 1, 2, 3 or 4 wherein the lubricating oil further contains an additive amount of an organomolybdenum compound.