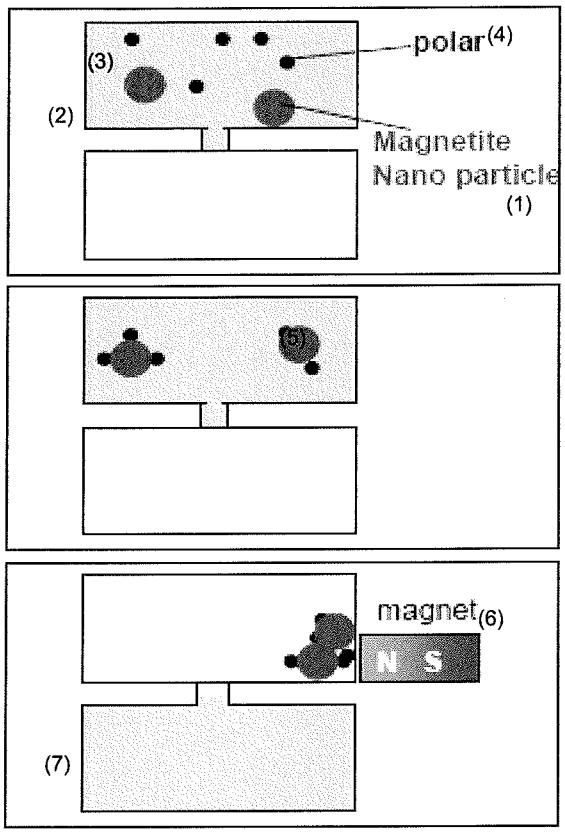

Fig. 1

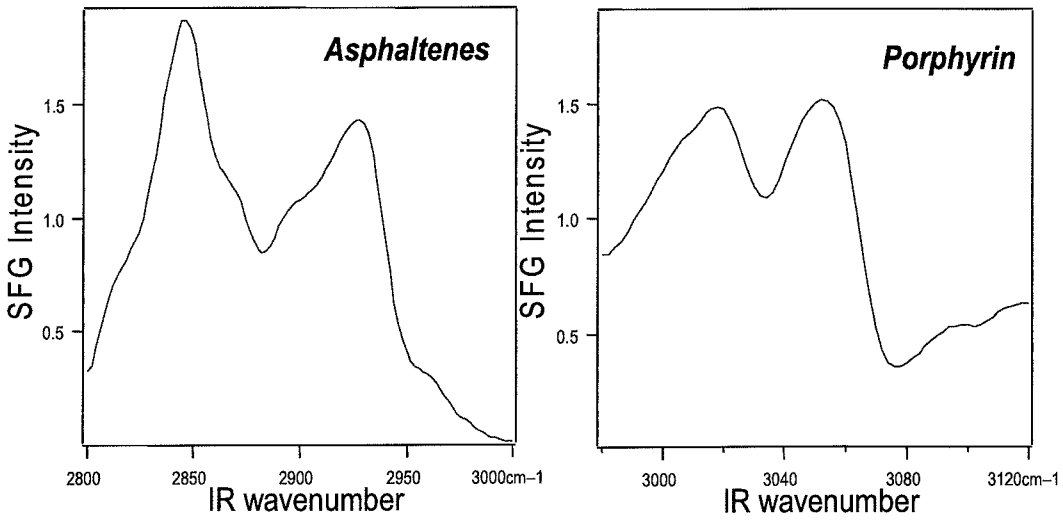
Asphaltenes
SFG Intensity
1.5
1.0
0.5
2800
2850
2900
2950
3000cm−1
IR wavenumber
Porphyrin
SFG Intensity
1.5
1.0
0.5
3000
3040
3080
3120cm−1
IR wavenumber

Figure 2

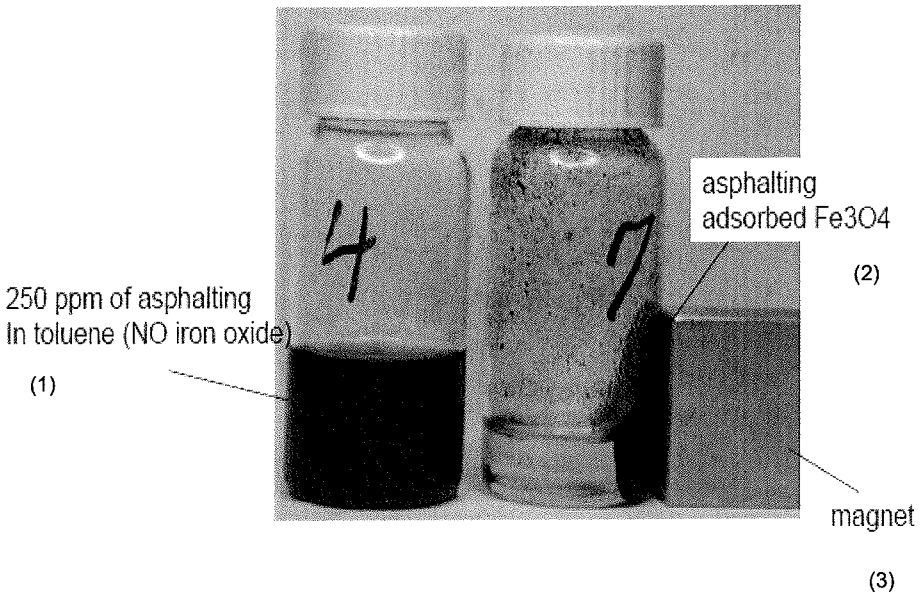
4
7
asphalting
adsorbed Fe3O4
(2)
250 ppm of asphalting
In toluene (NO iron oxide)
(1)
magnet
(3)

Fig. 3

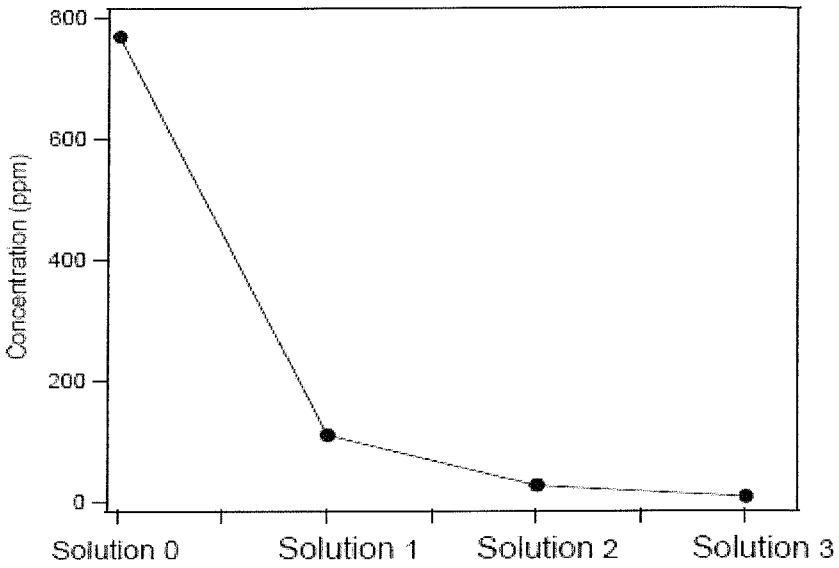
800
600
400
200
0
Concentration (ppm)
Solution 0
Solution 1
Solution 2
Solution 3

Fig. 4

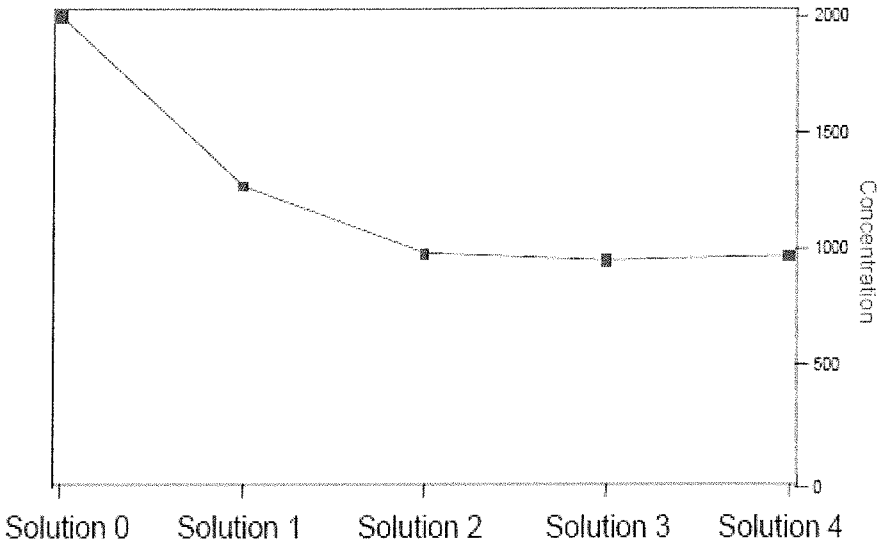
2000
1500
1000
500
0
Concentration
Solution 0
Solution 1
Solution 2
Solution 3
Solution 4

Fig. 5

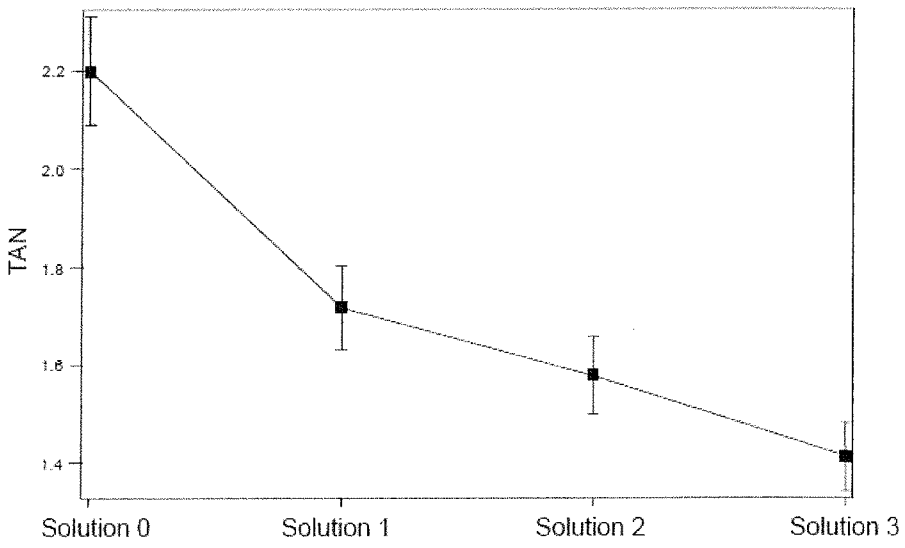

Fig. 6

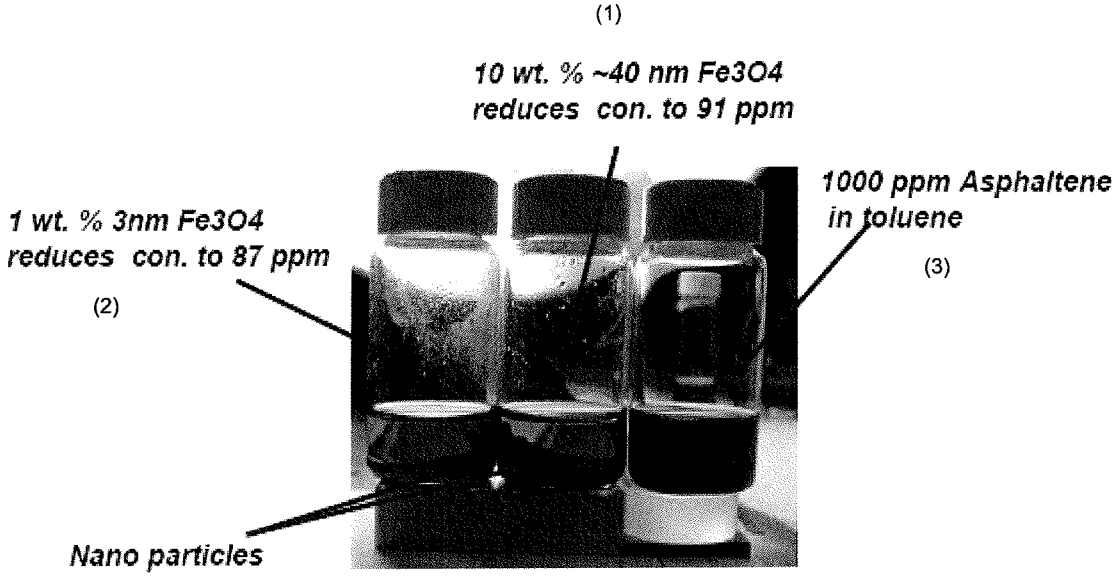
(1)
10 wt. % ~40 nm Fe3O4
reduces con. to 91 ppm
1 wt. % 3nm Fe3O4
reduces con. to 87 ppm
(2)
1000 ppm Asphaltene
in toluene
(3)
Nano particles

Fig. 7