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(54) **METHOD OF SURFACE MODIFYING GRAPHENE**

(56) **References Cited**

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U.S. PATENT DOCUMENTS

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7,745,528 B2 6/2010 Prud'Homme et al.
2010/0056819 A1 3/2010 Jang et al.
2014/0234200 A1* 8/2014 Tour C01B 31/0446
423/448

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OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

Sheng, et al., Catalyst-Free Synthesis of Nitrogen-Doped Graphene via Thermal Annealing Graphite Oxide with Melamine and Its Excellent Electrocatalysis, ACSNano 2011; 5(6): 4350-4358.*

* cited by examiner

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(57) **ABSTRACT**

(51) **Int. Cl.**
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A method of surface modifying graphene is disclosed and includes placing powder-like graphene into a closed container, heating up to a preset impurity detaching temperature higher than 100° C. so as to detach the impurity from the surface of graphene, further adjusting the treatment temperature to a preset surface modifying temperature, and injecting the gaseous surface modifying agent to be physically adsorbed by the surface of graphene. Thus, surface modified graphene is formed. The surface modifying temperature is higher than the sublimation temperature of the surface modifying agent and less than the decomposition temperature of the surface modifying agent. Therefore, the present invention is simpler and safer because of only physical adsorption used and no chemical reaction involved. Dispersibility of surface modified graphene in the solution is greatly increased to improve uniformity and enhance the performance of the final product formed of surface modified graphene.

(52) **U.S. Cl.**
CPC **C09C 1/44** (2013.01); **C01B 31/0492** (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

4 Claims, 5 Drawing Sheets

