Newly synthesized partially oxidized graphene as milk sensor

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Milk is an important food product which contains nutritional ingredients such as proteins (8.14 grams), carbs (12 grams), fats (8 grams), sugar (12 grams), vitamins, minerals, carbohydrates, hormones, etc. in 250 gram of pure milk. Micronutrient deficiency creates common health problems like anaemia, brittle bones, goitre etc., just to name a few. An estimated 42% of children under 5 years of age and 40% of pregnant women worldwide are anaemic. Milk and dairy industries are always under strict vigilance from food and drug safety administration to ensure that the quality and nutrition in milk is to the optimum level. However, there are several factors like addition of harmful additives, preservatives, artificial protein creator etc. which seek thorough analysis of milk samples over the time. At present, there are few standard methods (ELISA, HPLC, UVD-FD, SERS) to test the deterioration or purity of the milk. Poor sensitivity, low accuracy, sample pre-treatment, and high-cost equipments are serious limitations and therefore several research studies are going on to develop a cheap, new sensor to monitor the shelf-life/quality of the milk. Because of the functional oxide like band-gap and electronic properties with enriched surface characteristics, graphene oxide like material is chosen as a sensor material. To achieve an excellent electro-catalytic behaviour, in comparison to the other graphene derivatives, we have produced partially oxidized graphene (POG) using a new processing/exfoliation method. Towards this quest, we have developed a reliable and simple POG based sensor which could resolve a few of the existing limitations. The POG modified electrode is taken as working electrode in the designed novel electrochemical sensor to detect the spoilage/change chronology of the milk samples varying with time. The applied integrated sensor exhibits a reasonable sensing outcome with the 10 µL milk sampling. Within few seconds of transient cyclic voltammetry measurements, the maximum sensitivity ($\frac{\Delta I}{I}$) corresponding to the oxidation and reduction peak current is 36% and 29% respectively. Whereas, from the impedance spectroscopy, the achieved maximum sensitivity ($\frac{\Delta Z}{Z}$) is 191%. The well-defined response signal is obtained with the sampling linear range of 10-100 µL milk. The electrochemical analysis indicates that the molecular level change in the milk sample occurs within few hours of ageing.