

## Short Communication

# Cobalt Phthalocyanine Molecular Electrode for the Electrochemical Investigation of the Release of Glutathione upon Copper-Catalyzed Decomposition of *S*-Nitrosoglutathione

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## Abstract

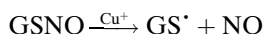
Decomposition of *S*-nitrosoglutathione (GSNO) in phosphate buffer solution at physiological pH 7.4 in the presence of cuprous ion as a catalyst and sodium borohydride as a reducing agent is analyzed by observing the transient apparition of reduced glutathione GSH through its electrooxidation. Transient formation of GSH, upon decomposition of 1 mM GSNO in presence of 0.025 mM Cu(NO<sub>3</sub>)<sub>2</sub> and 1 mM NaBH<sub>4</sub> was detected by using an ordinary pyrolytic graphite electrode modified with an adsorbed monolayer of cobalt phthalocyanine at 0 V vs. SCE.

**Keywords:** Cobalt phthalocyanine, *S*-Nitrosoglutathione, Reduced glutathione

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Nitrosothiols (RSNOs), also known as thionitrites, are biologically important molecules. They are believed to play an important role in storage, transport and release of nitric oxide (NO) [1] which is in turn involved in smooth muscle relaxation [2] and vasodilation [3] among its various physiological roles. *S*-nitrosoglutathione (GSNO) has been used clinically to inhibit platelet aggregation [4] and to treat high blood pressure in pregnant women [5]. Nitrosothiol decomposition reactions have thus been extensively studied with the aim of understanding RSNO pharmacology as well as the biochemistry of the homolytic cleavage products [1–10].

In general, RSNOs undergo homolytic cleavage of the S–N bond yielding nitric oxide (NO) and the corresponding RSSR disulphide [1–10]. Copper and selenium containing proteins have been reported to catalyze this reaction [11]. Furthermore, homolytic cleavage of RSNOs can also be triggered by light [12] or reduced metal assisted-catalysis such as Cu<sup>+</sup> [13, 14]. In order to get new insights into RSNO decomposition without dealing with additional side reactions related to GSH itself, which is part of the formed intermediates, we recently investigated studies of NO release from *S*-nitrosoglutathione (GSNO) decomposition by Cu<sup>2+</sup> in the presence of three different reducing agents: glutathione (GSH), sodium hydrosulfite (Na<sub>2</sub>S<sub>2</sub>O<sub>4</sub>) and sodium borohydride (NaBH<sub>4</sub>) [14]. This was performed by achieving the amperometric detection of NO released upon GSNO decomposition through the following overall reaction:



(followed by GSSG formation). Noteworthy, in the presence of NaBH<sub>4</sub>, the NO oxidation current linearly increased with Cu<sup>2+</sup> concentration and was directly proportional to NaBH<sub>4</sub> concentration for a given amount of Cu<sup>2+</sup> [14]. This work showed that, among the 3 reducing agents, NaBH<sub>4</sub> is the most efficient one to achieve GSNO decomposition [14]. Thus, its use is of interest for the analysis of the decomposition of RSNOs in biological model solutions. Indeed, NaBH<sub>4</sub> is a strong reducing agent that is able to reduce GSSG to GSH, to some extent, thus avoiding several side reactions [15, 16].

In order to have a complete sketch of the overall GSNO decomposition process, it is necessary to achieve the direct detection of both NO and GSH/GSSG. To do so, we have developed a cobalt phthalocyanine-modified electrode to electrochemically detect GSH residues in neutral aqueous solution [17].

In this work, GSNO decomposition reaction is studied in physiological buffer. NaBH<sub>4</sub> is used as reducing agent whereas Cu<sup>2+</sup> is used as a source of catalytically active Cu<sup>+</sup>. The reaction is monitored by electrochemical detection of the formed thiol by cyclic voltammetry. This will be afforded by the use of a cobalt phthalocyanine (CoPc) adsorbed on ordinary pyrolytic graphite (OPG) electrode. In this context, we show for the first time the possibility of electro-detecting GSH oxidation formed upon Cu<sup>+</sup>-catalyzed decomposition of GSNO.

OPG electrode was modified by adsorption of CoPc (see details in Experimental). Figure 1 (curve a) shows typical cyclic voltammograms of OPG after adsorption of CoPc in