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Methylviologen mediated electrochemical reduction of AgCl—A new route to produce a silica core/Ag shell nanocomposite material in solution

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ABSTRACT

Methylviologen mediated electrochemical reduction of AgCl precipitate to Ag^0 in the presence of alkylamino-modified silica nanoparticles (SiO_2-NHR) in an aqueous medium was performed. The main products of reduction at potentials of the $MV^{2+}/MV^{\bullet+}$ redox couple are spherical SiO_2-NHR/Ag core/shell nanoparticles (size range 120–160 nm) in solution.

1. Introduction

In recent years, metal nanoparticles are one of the most widely studied nano-objects. The keen interest in these objects is due to the wide variety of their potential applications in catalytic, biomedical, optical, electronic and other fields [1–7]. The methods of preparation of metal nanoparticles are quite diverse. They can be tentatively divided into physical, chemical, biochemical and electrochemical methods. Currently, chemical reduction of metal ions (complexes) in solution using various reducing agents is the most successful method.

The electrochemical method is widely used to produce metal nanoparticles immobilized on a conducting support (electrode). Various implementations of this method are summarized in the fundamental review by O.A. Petrii [8]. However, electrochemical methods for the preparation of metal nanoparticles in other states (in solution, on non-conductive solid supports, in matrices, in nanocapsules, etc.) that are in greater demand have been developed much less thoroughly. Metal nanoparticles are prepared in solution using pulse sonoelectrochemistry [9–11], Reetz's method [12–16] and mediated electrosynthesis [17–20]. The latter method compares favorably with the previous two ones in that the reduction of metal ions is moved from the electrode surface into solution. This method gives a principally new possibility for production of metal nanoparticles in the case where direct reduction of metal ions at the electrode is difficult or impossible, for instance due to insolubility or low solubility of their salts; when they are encapsulated in the micelles, polymer globules or other matrices; and when they are immobilized on a non-conductive solid support. This paper demonstrates this possibility for methylviologen mediated reduction of insoluble AgCl salt in the presence of alkylamino-modified silica nanoparticles

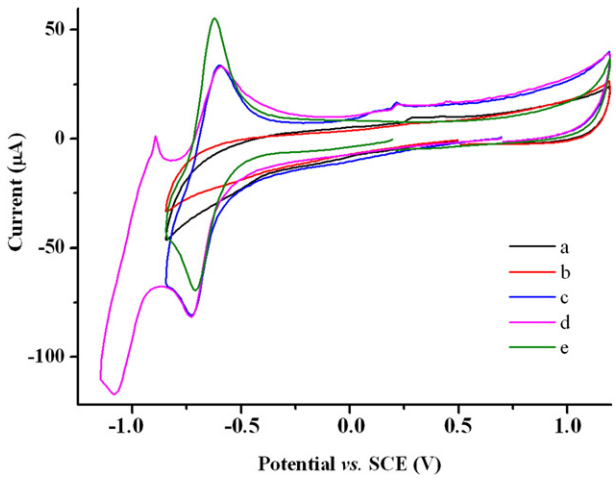

Fig. 1. CV curves for 0.2 g/L AgCl (a), 0.2 g/L AgCl + 1.0 g/L SiO_2-NHR (b), 0.2 g/L AgCl + 1.0 g/L SiO_2-NHR + 2 mM MV^{2+} (c, d) and 1.0 g/L SiO_2-NHR + 2 mM MV^{2+} (e). H_2O, 0.1 M $NaBF_4$, glass carbon electrode. ν = 00 mV/s.

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