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Influence of NaBH4 reduction on the hydrogen storage properties of aniline/Pd composite materials

Whitney Shofner
University of Nevada Las Vegas

David W. Hatchett
University of Nevada, Las Vegas, david.hatchett@unlv.edu

Whitney Shofner
Mentor - David Hatchett

The characterization and chemical synthesis of composites containing aniline and N-Phenylenediamine (NPPD), synthesized with palladium, will be analyzed according to recent studies [1] to confer hydrogen storage capabilities. The palladium metal will be introduced as either $PdCl_4^{2-}$ or $PdCl_2^{2-}$. The experiments will be carried out under both acidic and non-acidic conditions forming a total of 8 different compounds. Each compound will be reduced with $NaBH_4$ and analyzed using gas chromatography to measure hydrogen storage. Infrared spectroscopy and ultraviolet visible spectroscopy will also be used to gather data concerning each compound.

Influence of $NaBH_4$ Reduction on the Hydrogen Storage Properties of Aniline/Pd Composite Materials

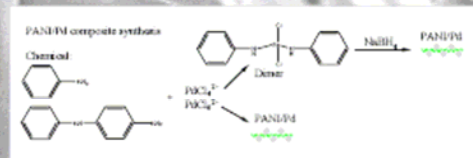
Whitney Shofner and Dr. David W. Hatchett
Department of Chemistry
University of Nevada, Las Vegas

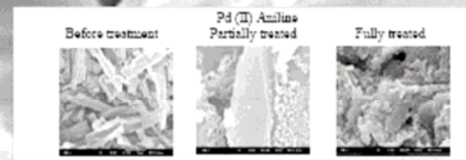
Abstract

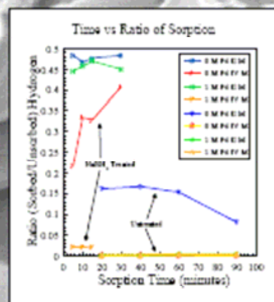
The chemical synthesis and characterization of composites containing aniline and N-Phenylenediamine (NPPD) is examined [1]. The synthesis is achieved using palladium anions without additional oxidant. The palladium anions utilized in the synthesis were $PdCl_4^{2-}$ and $PdCl_6^{2-}$. The influence of acid on the materials produced in the synthesis were examined. A total of eight different compounds were produced and evaluated for their hydrogen storage properties. In addition, each compound was further reduced with $NaBH_4$ and analyzed again using gas chromatography to measure the hydrogen storage properties after treatment. The goal is to produce materials that can reversibly sorb hydrogen for fuel applications.

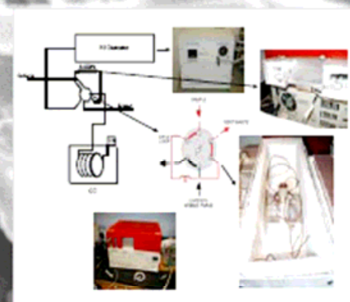
Introduction

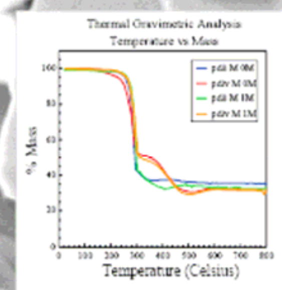
The use of conductive polymers in energy applications has increased recently due to the unique properties of the materials. The polymers behave like metals while retaining the properties of polymer materials improving processing and use in more novel applications. For example, conductive polymers have been used in the development of hand prosthetics [2], earthworm-like robots [3], and in antifouling/antistatic films. Polyaniline is one of the most environmentally stable polymers and is easily processed through chemical or electrochemical methods. It has been used for energy applications including fuel cells and batteries. More recent studies [1] have examined the hydrogen sorption properties of the pristine polymer with mixed results. In one study the sorption of hydrogen was estimated at 6% by weight. In contrast, a second study found the polymer sorbed no hydrogen. The discrepancies associated with hydrogen storage of polyaniline are not well understood and may well be influenced by the method of preparation, any secondary treatment of the material, or experimental conditions such as pressure and temperature used during hydrogen storage [4] [5] [6]. Palladium has well known hydrogen storage properties through the formation of metal hydride bonds. Therefore, the incorporation of Pd into polyaniline should enhance the storage properties of the materials produced. The goal of this study was to produce composite materials with hydrogen storage properties using aniline or N-phenylenediamine reacted with either $PdCl_4^{2-}$ or $PdCl_6^{2-}$ in acidic and neutral solutions. In addition, the hydrogen sorption properties were measured using an in-house gas chromatograph equipped with a hydrogen generator. In the event that Pd was not fully reduced in the synthesis, the composite materials were further reacted with reducing agent $NaBH_4$. The reduced samples were then compared to the untreated composite materials to determine the influence of Pd reduction on the hydrogen storage properties.

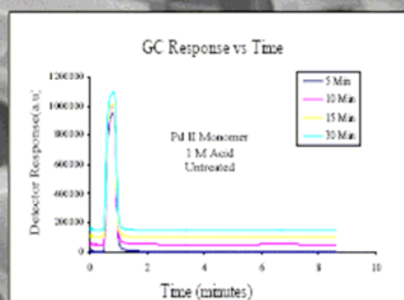


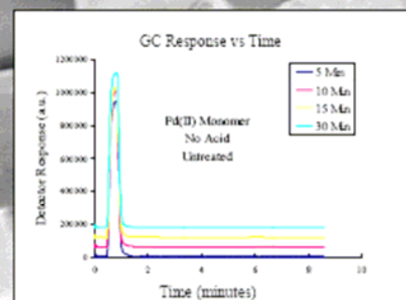


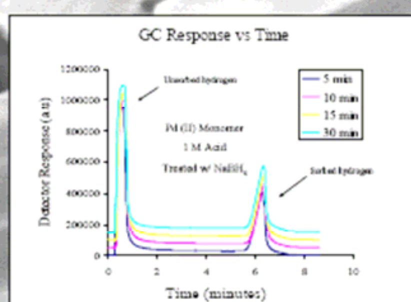


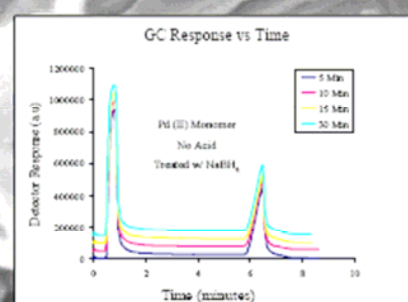












Conclusion

The data shows that complexes reduced with sodium borohydride store more hydrogen after treatment. No hydrogen sorption is observed for the unreduced Pd (II) samples. However, sorption of hydrogen is observed for the samples after they were treated with sodium borohydride. The differences in sorbed vs. unsorbed hydrogen peaks are represented as ratios for samples that were treated as well as those that were not treated. The Pd (II) aniline complexes with and without acid proved to be the most effective at hydrogen storage. The unreduced samples consist of Pd(II)/aniline complexes showing little hydrogen sorption. The formation of Pd metal after reduction results in a significant enhancement of the hydrogen sorption properties.

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References

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