DEPOSITION OF NICKEL-PHOSPHOROUS PLATINGS ON CARBON NANOTUBES

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Introduction

Carbon nanotubes are a new class of materials that are currently being studied intensively by many researchers. An increased interest to them has been generated by their unique characteristics, especially autoemission properties resulted from electron tunneling through a potential barrier on the surface of cathode body. However, in development of specific products with using nanotubes, numerous technological difficulties connected with the dimensional factor and low chemical activity of their sidewalls emerge. There is necessity in fixing nanotubes in the matrix of the autocathode and cladding leads in view of high mechanical and electrical loads generated in its operation.

Results and Discussion

With the aim to increase the catalytic and adhesive properties of nanotubes, different metallic platings, e.g. nickel and palladium with preliminary activated surfaces can be deposited on them [1-23]. We propose the method of deposition of nickel platings in aqueous solutions with using reducers without preliminary chemical activation. In order to obtain authentic data in the course of the metallization process, nanotubes synthesized by pyrolysis of hydrocarbons on the apparatus designed in laboratory 67 in IPMS of NaSY; were used, as a starting material. A homogeneous dispersion of the starting material in the metallization solution was provided by ultrasonic treatment of samples for 5 min. The induction period preceding the beginning of the intensive development of the deposition reaction ranged from 20 to 60 min for different batches. It should be noted that certain numbers of nanotubes having hydrophobic surfaces were present, in samples. This caused the formation of a black deposit in the upper part of the unit. However, since the metallization reaction proceeds to completion, which is evidenced by the complete decolorization of the solution, it can be concluded that nickel deposited on the surface of the used primer (nanotubes).

To confirm the preliminary conclusion, the composition of the prepared materials was studied by the IR spectroscopy method with using a Specord 75-IR spectrometer and by X-ray phase analysis on a DRON–2.5 diffractometer. The obtained results indicate the presence of a great amount of nickel in samples, what is a consequence of a large excess of nickel in the prepared metallization solutions. The proposed method makes it possible to control the amount of the deposited material in very wide ranges, i.e., from several tenths of a percent to hundreds of percents by mass. In the diffraction pattern, the peak of nickel is of interest. The peak has a rather noticeable broadening, which indicates the amorphous character of the obtained plating. This amorphization is explained by the fact that phosphorous atoms enter the crystal lattice of nickel, which is characteristic for using sodium hypophosphite as a reducer. A similar phenomenon is observed for nickel-phosphorous platings on compact materials [2]. However, in the case when nanosized materials are used as a substrate, metallic coatings also take on an amorphous character. This is due to high dispersity of the product produced or, in our case, due to deposition of Ni particles on the highly dispersed initial substance.

Conclusions

1. A preliminary ultrasonic treatment of synthesized nanotubes can be used to purity and disperse homogeneously them in metallization solutions and to activate the surface instead of chemical activation.
2. Nickel-phosphorous platings formed on carbon nanotubes are amorphous in character what evidences nanoscale the particles deposited.

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МЕТОД НАНЕСЕНИЯ НИКЕЛЬ-ФОСФОРНЫХ ПОКРЫТИЙ НА УГЛЕРОДНЫЕ НАНОТРУБКИ

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Введение

Углеродные нанотрубки – новый класс материалов, которые в настоящее время интенсивно изучаются многими исследователями. Повышенный интерес к ним вызван их уникальными характеристиками, особенно автоэмиссионными свойствами, связанными с туннелированием электронов через потенциальный барьер на поверхности тела катода. Однако в процессе создания конкретных изделий с использованием нанотрубок возникают многочисленные технологические затруднения, связанные с размерным фактором и низкой химической активностью их боковых стенок. В частности, существует необходимость закрепления нанотрубок в матрице автокатода и нанесения токоввод в связи с высокими механическими и электрическими нагрузками, возникающими при его работе.

Результаты и обсуждение

С целью увеличения каталитических и адгезионных свойств на нанотрубки наносят различные металлические покрытия, например никель или палладий с предварительным активированием поверхности [1]. Нами предложен метод нанесения никелевых покрытий в водных растворах с использованием восстановителей без предварительной химической активации. Для получения достоверных сведений о протекании процесса металлизации в качестве исходных были взяты нанотрубки, синтезированные методом пиролиза углеводородов на установке, сконструированной в лаб. № 67 ИПМ НАН Украины. Равномерное диспергирование исходного материала в растворе металлизации было обеспечено ультразвуковой обработкой навески в течение 5 мин. Индукционный период перед началом интенсивного протекания реакции осаждения составлял от 20 до 60 мин. для различных партий. Следует также отметить наличие в образцах определенного количества нанотрубок, обладающих гидрофобной поверхностью, что привело к образованию черного налета в верхней части установки. Однако, вследствие протекания реакции металлизации до конца, о чем можно судить по полному обесцвечиванию раствора, правомерно сделать вывод об осаждении никеля на поверхности введенной затравки (нанотрубках).

Для подтверждения предварительных выводов состав полученных материалов был исследован методами ИК-спектроскопии на приборе SPEKORD 75-IR и рентгенофазовым анализом на ДРОН-2.5. Полученные результаты свидетельствуют о наличии большого количества никеля в образцах, что является следствием приготовления растворов металлизации с большим избытком никеля. Данный метод позволяет регулировать количество осаждаемого металла в очень широких пределах – от долей до сотен процентов по массе. Представляет интерес характер пика никеля на рентгенограмме – он имеет явно выраженное уширение, свидетельствующее об аморфном характере полученного покрытия. Данная аморфизация объясняется внедрением атомов фосфора в кристаллическую решетку никеля, что характерно при использовании в качестве восстановителя гипофосфита натрия. Подобное явление отмечается для никель-фосфорных покрытий на компактных материалах [2]. Однако и в случае применения в качестве подложки материалов, имеющих наноразмеры, металлическое покрытие также приобретает аморфный характер. Это объясняется высокой дисперсностью получаемого продукта или, в нашем случае, осаждением частиц Ni на высокодисперсном исходном веществе.

Выводы

1. Предварительная ультразвуковая обработка синтезированных нанотрубок может быть использована для очистки и их равномерного диспергирования в растворах металлизации, а также для активирования поверхности вместо химической активации.
2. Образующееся на углеродных нанотрубках никель-фосфорное покрытие имеет аморфный характер, что свидельствует о наноразмерности осевших частиц.

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