

Electrospinning of Flavin Mononucleotide-Functionalized Single-Walled Carbon Nanotubes

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Abstract

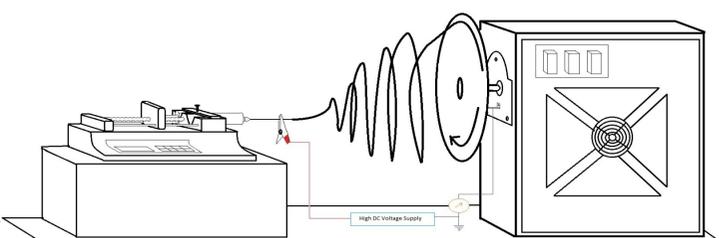
In this contribution, we describe the flavin mononucleotide (FMN) cofactor onto carboxylic functionalities of single-walled carbon nanotubes (SWNTs), using an electrospinning process to create the continuous nanoscale composite fibers from carbon nanotubes and polymer and FMN. The synthesis of FMN derivative was possible by coupling flavin H-phosphonate with an aliphatic alcohol, and the flavin moiety of 12-SWNT shows a strong interaction with the nanotube side-walls. This leads to a collapsed FMN configuration that quenches flavin photoluminescence (PL). These findings provide a fundamental understanding for flavin-related SWNT nanostructures that could ultimately find a number of usages in nanotube-mediated biosensing devices.

Introduction

Flavin is an important redox moiety for one- and two-electrontransfer cycles in cell membranes. A number of applications have surfaced involving these cofactors in the presence or absence of apoproteins in the area of biosensors. Flavin Mononucleotide (FMN) is a biomolecule produced from vitamin B2 and is an important luciferin (i.e., bioluminescent cofactor). The unique electronic and electrochemical properties of single-walled carbon nanotubes (SWNTs) have inspired a number of biosensing methodologies for proteins. Polyvinyl alcohol (PVA) is a water-soluble synthetic polymer, it has excellent film forming, emulsifying and adhesive properties. It has high tensile strength and flexibility, as well as high oxygen and aroma barrier properties. The effects of polymer on the fiber structure of electrospinning PVA is the flat fibers were observed at high molecular weight and concentrations. A recent theoretical study indicates that the flavin-related SWNT nanostructures that could ultimately find a number of usages in nanotube-mediated biosensing devices.

Experimental Details

In this research, our experimental method is to create two different groups (CNT with FMN and CNT without FMN) with different concentration of PVA under the same electrospinning conditions are investigated in relation to their capability of producing nanofibers. The instruments include high voltage generator, dual syringe pump, and the



As shown in Figure 1 electrospinning setup has a dual syringe pump, 0-30KV DC high voltage electric power supply and a collector. The needle attached to the syringe is connected to a positive electrode and the collector is grounded. We apply a high voltage as high as 15 KV in order to produce the nanofibers. The solution was prepared in water at a concentration of 10 % w/v. A weighted amount of PVA powder (Sigma Aldrich, Inc.) was dissolved in the water at 90° C, under slight stirring for 2 hours until we get crystal clear solution. A fixed electrical potential of 15 KV was applied over a fixed distance of 15 cm (approximately 1KV over 1cm) at a rate of 0.5ml/hr. We dispersed CNT in 10 % PVA solution under strong sonication for 1 hr. Here we applied a fixed voltage of 15kV over a fixed distance of 10 cm.

Conclusion

These findings provide a fundamental understanding for flavin-related SWNT nanostructures that could ultimately find a number of usages in nanotube-mediated biosensing devices. The fibrils may show superior properties and can be used as a bioluminescent cofactor material for biosensing devices.



Fig 2. electrospinning process of flavin mononucleotide (FMN) and single-walled carbon nanotubes (SWNTs)

Conditions of the experiment



- * Experiment Date: 6/17/2013
- * Sample 1: 1mL FMN SWNTS + 1mL 20% PVA
- * Rate: 0.5mL/H
- * Distance: 15cm
- * Voltage: 15KV
- * Time: 2Hours
- * Observation: cone formed on the jet, yellow dots and nanofibers like formed on the collector.

Conditions of the experiment



- * Experiment Date: 6/17/2013
- * Sample 2: 1mL SWNTS + 1mL 20% PVA
- * Rate: 0.5mL/H
- * Distance: 15cm
- * Voltage: 15KV
- * Time: 2Hours
- * Observation: cone formed on the jet, white dots and nanofibers like formed on the collector.