OPTIMIZATION OF A GREEN SYNTHESIS OF CdSe/ZnS NANOCRYSTALS AND THEIR BIOCONJUGATION TO DNA

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Two synthetic methods of cadmium selenide/zinc sulfide (CdSe/ZnS) core/shell quantum dots (QDs) were explored. The first method was a phosphine-free synthesis that utilized mineral oil as the solvent. Although this method provided a greener synthesis, it produced inconsistent QDs with little fluorescence stability. The second synthetic method involved tri-n-octylphosphine (TOP) and utilized zinc diethyldithiocarbamate (Zn(DETC)2) as a single-source precursor for the ZnS shells, which gave more consistent results. Two methods involving 3-mercaptopropionic acid (3-MPA) as an aqueous ligand were investigated. One of these methods used ethylenediamine (EDA) as an intermediate ligand during the aqueous phase transition, and the other method used tetramethylammonium hydroxide pentahydrate (TMAH). The EDA-mediated ligand exchange enabled the QDs to retain their fluorescence while the TMAH method repeatedly quenched the fluorescence of the QDs. Strands of DNA, varying in length, were attached to the aqueous QDs, although significant aggregation was observed in most cases.

In Vitro and *In Vivo* Studies on the Solubility and Tissue Penetration of PAT Excipients Infused through a ClearWay Atrium RX Balloon Catheter

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Delivering a significant portion of the drug paclitaxel (PAT) to the diseased arterial wall for peripheral vascular disease applications remains a problem. In this study, a ClearWay Atrium RX Infusion balloon was used to determine the best excipient to deliver the most and retain the least PAT on the balloon. Also, smooth muscle and endothelial cell studies were done to determine the viability and proliferation of them in the presence of the prepared solutions. *In vivo* studies on rabbits were finally done to determine the tissue penetration of the PAT drug into the arterial wall.

Surface Modification of CoCr alloy Surfaces using Molecular Coatings for Improved Blood Compatibility.

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CoCr alloy is extensively used in cardiovascular medical devices because of its excellent physical and mechanical properties. However after implantation, adsorption of proteins and subsequent adhesion of blood platelets on alloy surfaces result in the formation of blood clots i.e. thrombus. Ultimately, this thrombus may block the blood vessels that supply blood to various organs and could cause fatal complications. Hence, the focus of this study is to develop molecular coatings on CoCr alloy using phosphoric acid and phosphonoacetic acid, and to investigate albumin and fibrinogen adsorption, and platelet adhesion, activation, and aggregation on surface modified CoCr alloy surfaces.

Detection of Early Onset of Metal Corrosions

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Abstract:

Metal corrosions cause severe damages and require great efforts in repairs and replacements of mechanical parts. Rhodamine B and fluorescein dyes were synthetically modified to bind or chelate to the byproducts of metal corrosion in order to detect corrosion. Ketones and aldehydes groups were attached onto Rhodamine B and fluorescein to determine the effects of steric hindrance and electron withdrawing/donating substituents. Ketones were utilized to probe the effect of steric hindrance on dye-metal binding, while aldehydes containing different electron withdrawing/donating substituents investigated the electronic effects on dye-metal binding. Fluorescence spectroscopy was utilized to characterize dye-metal binding. Successful synthesis of multiple hydrazones and dye-metal binding fluorescent tests were achieved. Spectrofluorimetry data showed inconclusive fluorescent results for the metals.

Release of Nitric Oxide from Heparin Coated Cobalt-Chromium (Co-Cr) Surfaces

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Introduction: Drug eluting stents (DES) are currently used to treat coronary artery disease (CAD). The use of DES has highly reduced the occurrence of neointimal hyperplasia and thus prevented the renarrowing of the treated artery [1]. However, the anti-proliferative drugs such as paclitaxel, and sirolimus used in currently available DES have shown to impair vascular healing because of improper endothelialization and causing late stent thrombosis (LST) [2]. Also, some polymers used to obtain the sustained release of these drugs have shown to cause hypersensitive reactions thus leading to LST [3]. A stable heparin coating can reduce the chance of LST because of its excellent anti-thrombogenic property. Also, the delivery of nitric oxide (NO) has shown to inhibit the growth of smooth muscle cells (SMC) as well as promote endothelialization [4]. In this study, the stability of heparin coating on Co-Cr stent material using different concentrations of bovine serum albumin (BSA), pH of coating solution, and the incorporation of NO in the coating were investigated.

Methods: Co-Cr alloy plates (1 cm x 1 cm) were cleaned by sonicating in ethanol, acetone and methanol twice for 10 min each. A coating solution containing 1 % Heparin and 1 % BSA in deionized water was prepared at the pH of 11, 10, 9, 8, 7.4, 7, 6.5, 6, and 4 using either 1 M NaOH or 1 M HCl. A 100 µL of the obtained coating solution was microdrop deposited onto the Co-Cr alloy surface and the samples were dried in a vacuum oven for 20 h at 50 ˚C and -15 Hg vacuum. The stability of coating was determined by immersing each sample in 30 mL of PBS. After determining the pH to obtain better stability of coating (pH of 4), coating solutions containing 1 % heparin, and 1 % BSA at pH 4 were prepared with four different concentrations (0.01, 0.1, 0.5, and 1 %) of DETA NONOate incorporated. The samples were then immersed in PBS and placed in a water bath at 37 ˚C for 3 days. The amount of NO released into the PBS was determined by ozone-chemiluminescence process using Sievers nitric oxide analyzer (NOA). The morphology of coating was studied using scanning electron microscopy (SEM).

Results: The samples with pH of 6 to 11 showed poor stability in PBS. The coatings of these samples were dissolved in PBS within 2 min. The pH of 4 significantly improved the stability of coating and the coating was intact for upto 45 min which clearly showed that pH of the coating solution has an effect on the stability of heparin coating. The stability of NO in the PBS solution released from the coating was found to be good still after 3 days. SEM images showed that the coating became thicker with the increase in % of BSA in the coating solution. The images taken from the edge of the coating indicated that the coating was nicely adhered onto the Co-Cr alloy plates. The coating has become smoother with the addition of a plasticizer (glycerol) to the coating solution.

Conclusions: The stability of heparin coating was significantly increased by mixing it with BSA at pH of 4. NO was successfully released by incorporating DETA NONOate in this coating. A smooth coating was obtained by adding glycerol as a plasticizer.

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