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Multicomponent biomaterials for improved storing, sensing and release

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Recent interest in designing micro and nano-sized drug delivery systems and layers is oriented on creation of delivery systems for poorly soluble and/or highly unstable substances. In our work, we would like to expand the synthesis ways and optimization steps needed for preparation of multicomponent biomaterials with improved storage, delivery and sensing properties. Firstly, we would like to present steps involved in the application of charge controlled coaxial core-shell electrospinning process for creation of thin micro and nanocomposites of PLC/PNIPA/DNA/Au NPs with attached selected anti-tumor drugs. They were attached by non-covalent and covalent bonding sensitive to tumor environment. Modified gold nanoparticles were entrapped in PLCL fibers during electrospinning process. We investigated the release profiles of drug-modified Au NPs from PLC nanofibers, by spectroscopic (UV-Vis, CD) and electrochemical techniques (CV, SWV) and *in vitro* experiments (HeLa, Insulinoma and Glioma cells). The morphology of composites was inspected by TEM, SEM and optical microscopy. Secondly, we would like to show several kinds of metallic NPS and hydrogel based nanoparticles modified by selected aptamers. We applied PAM and PNIPA hydrogel networks, for formation of multicomponent nanoparticles for storing of selected antitumor intercalators and releasing of it after initiation of structural changes of aptamers and volume phase transition of lattices. The DNA-based biomaterials were characterized by a strong increase in guanine and adenine anodic currents that starts at physiological temperature. The structural alterations were used as a control element in the releasing of drugs. Thirdly, we would like to expand the possibility of application of multicomponent, metallic NPS and hydrogel-based nanoparticles modified covalently with selected aptamers as sensing layers used in electrochemical sensors. We optimized the design process of such biosensors for improved detection of MUC1 protein.

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A fully integrated powerline filter for biopotential acquisition systems

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Low frequency filters has wide range of applications in biomedical signal processing. It is particularly desired for biopotential acquisition systems to eliminate powerline frequency disturbance from the measured signal using analog notch filters. Such interference concurrently occurs within the same band where biopotential and other physiological signals have most of their energy. Examples include ECG, electroencephalogram (EEG), and electromyogram (EMG) recordings. The work assesses the available solutions. Then, it presents a new notch filter design avoiding common drawbacks and providing improved characteristics. The proposed notch filter incorporates R-2R ladders allow the realization of large time constant in small area. The main features of the presented solution include (i) Integration into a single chip (i) Low power consumption in order to reduce amount of heat, decrease battery size and increase battery life, and (iii) High linearity to avoid generating harmonics that could be more dangerous than the powerline interferences. In fact, low noise requirement (to process the weak physiological signals) would be relieved in presence of pre-amplification and would converge to requirement (iii). Programmability is also incorporated to adjust the filter zero frequency compensating for inaccurate component values, process variations, and temperature changes. The proposed filter design is systematically identified to be the optimum. Main claims are supported with analytical proofs. Also, the operation and results are verified through IC fabrication and experimental results. Experimental results show significant improvement in terms of power consumption and linearity compared with the available solutions. Also, measurement validations using real biomedical signals are provided.

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