ELECTROPOLYMERIZED POLYMER COATINGS FOR STAINLESS STEEL

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Introduction

Stainless steel (SS) 316L is often used for medical applications, e.g. for fabrication of stents or artificial valves. However, these life-saving devices have negative long-term influence on tissues of a patient. Adsorption of platelets and leukocytes leads to formation of blood clots and inflammation [1]. Also, steel releases toxic ions (e.g. Cr or Ni); in the case of stents there is also a problem of restenosis [2]. Many approaches has been undertaken to solve these problems [3], however none of them seems to be good enough. In present paper we claim that it is possible to obtain biocompatible and hemocompatible polymer coating for steel that could also be functionalized and grafted with endothelium-specific peptides.

Materials and Methods

Polymer coating on SS 316L flat discs (ø14mm) was obtained through electropolymerization method. SS disc was dipped in the aqueous solution containing poly(glycol dimethacrylate (PEGDMA), crosslinking/polymerization substrate - ammonium persulphate ($(NH_4)_2S_2O_8$), crosslinking agent - ethylene glycol (EGDMA) and additives improving the quality of coatings. DC power supply was used as a power source. Decomposition of $(NH_4)_2S_2O_8$ triggered by passage of current led to radical crosslinking of PEGDMA resulting with forming a crosslinked PEGDMA (cPEGDMA) coating on SS surface. cPEGDMA coating was functionalized thanks to addition of acrylic acid (AA) to the reaction solution. Then peptide molecules containing adhesive sequence (GSGREDVGSG) were grafted to superficial COOH groups utilizing EDC/sulfoNHS protocol. cPEGDMA coating was analyzed with the use if SEM and FTIR-ATR. The concentration of AA and time of AA electropolymerization was tested using TBO method of COOH groups quantity. Peptide presence was determined e.g. via BCA colorimetric assay.

Results and Discussion

FIG. 1 shows FTIR-ATR spectra of SS surface coated with AA at AA concentration of 1%(v/v) and different reaction times: 5, 15 and 30min. Characteristic peaks indicating chemical groups are highlighted. The intensity of the peak at 3400cm^{-1} is the smallest for SS-PEGDMA (at the bottom) and the biggest for 30min of reaction (at the top). So, as reaction time increases, the number of COOH is increasing. It is understandable since the longer time of AA polymerization, the more monomers are incorporated in the polymer chain, thus the more COOH groups are present. It was also reported by other authors who used the same method of COOH groups quantification in the study considering polyurethane scaffolds radically grafted with AA [4].The effect of AA concentration was also studied. It was demonstrated that for higher AA concentrations the COOH content is increased, which corresponds to other works [4,5].

FIG. 2 presents BCA assay results for carboxylated SS chemically grafted with adhesive peptide (marked as SS-REDV edc/nhs, two sets of carboxylation parameters were used: 30% (v/v) of AA, 30min and 1% (v/v) of AA, 5min) with comparison to SS alone (SS) and carboxylated SS incubated, not grafted with peptide solution (marked as SS-REDV ads) in order to see how much physical adsorption of REDV alters the results. SS-REDV edc/nhs seems to pisses the biggest number of REDV molecules, however it is also significantly adsorbed in polymer matrix. Since SS also gives a high response in BCA assay, another method of REDV evaluation is needed.

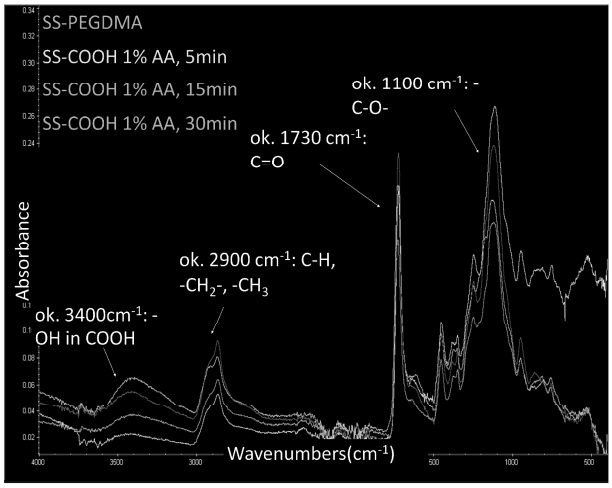

FIG. 1. FTIR-ATR spectra of SS surface coated with AA at AA concentration of 1%(v/v) and different reaction times.

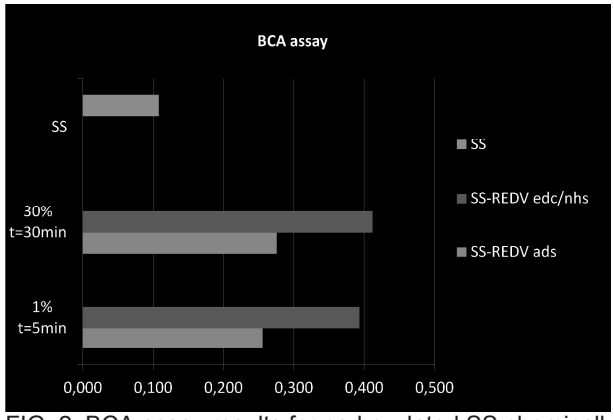

FIG. 2. BCA assay results for carboxylated SS chemically grafted with REDV peptide (SS-REDV ads), carboxylated SS with REDV adsorbed, not grafted and SS alone. Two sets of carboxylation parameters were used.

Conclusions

It has been demonstrated that SS can be coated with polymer layer that offers a potential of functionalization. Superficial carboxyl groups could be used for peptides grafting. More results will be shown including more detailed polymer coating characteristic as well as endothelial cells culture of SS-REDV surfaces.

Acknowledgments

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