Preparation of PIPAAm modified silicone elastomer by using electron beam irradiation

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Statement of Purpose: Poly(dimethylsiloxane) (PDMS) is widely used for microfabrication research field, because of its mechanical properties, biocompatibility, transparency, gas permeability and low cost. Such properties are attractive for tissue engineering filed, however, it is known that the cells are not difficult to adhere to PDMS surfaces. Different methods have been reported for the modification of PDMS surfaces to be cell adhesive surfaces. In contrast, electron beam (EB) irradiation has been exploited for the modification of the target surfaces with polymers. Advantage of the EB irradiation is that the target surface is easily modified with appropriate polymer. In actual, poly(*N*-isopropylacrylamide) (PIPAAm) was grafted onto tissue culture polystyrene (TCPS), polyethylene terephthalate and glass surfaces by using EB irradiation. In this study, we prepared PIPAAm modified PDMS surfaces by using EB irradiation, and characterized the surfaces as the temperature-responsive cell culture surfaces.

Methods:PDMS sheet (STREX. Inc.(Osaka, Japan)) was cut into the square sheest (2.0cm x 2.0cm). The square sheets of the PDMS were immersed into the HCl solution to produce the silanol groups. 3-methacryloxypropyltrimethoxysilane (MPTMS) was introduced onto the sheets surfaces (30min, 70°C). IPAAm monomer dissolved in 2-propanol (10-40wt%) was uniformly spread onto the MPTMS modified sheet. And the, the sheet was subjected to the EB irradiation and graft the PIPAAm onto the sheet. Resulting sheet was washed with water and was dried at 45°C (12h). On the basis of the initial monomer concentration, the PIPAAm modified PDMS was abbreviated as 10PIPAAm-PDMS (10 wt% IPAAm monomer), 20IPAAm-PDMS, 30IPAAm-PDMS and 40IPAAm-PDMS. These PIPAAm-PDMSs surfaces were characterized by FT-IR / ATR, XPS and cell attachment and detachment assay.

Results: Fig. 1 shows FT-IR/ATR spectra of PIPAAm modified PDMS surfaces prepared at different IPAAm monomer concentration (10-40wt%). The wide range spectra showed absorption peaks characteristic of PDMS; 795 cm-1 (the methyl rocking and Si-C stretching vibration), 930 cm-1 – 1200 cm-1 (asymmetric stretching vibration of Si-O-Si group), 1259 cm^{-1}, 1412 cm^{-1} and 1446 cm^{-1} (deformation vibration of methyl groups), 2906 cm^{-1} and 2963 cm^{-1} (stretching vibration of the methyl groups), 3655 cm^{-1} (stretching vibration of hydroxyl groups). The narrow range spectra showed absorption peaks assigned to the C=O stretching vibration of an amide groups (1545 cm^{-1} and 1655 cm^{-1}). The amide groups are from the modified PIPAAm. With an increase in the initial IPAAm monomer concentration, peak intensity ratio (I_{1650}/I_{1080}) increased. This result indicates that PIPAAm was successfully grafted onto PDMS surfaces by use of EB irradiation.

The contact angle of the PDMS and PIPAAm-PDMSs were investigated. Grafting PIPAAm onto PDMS slightly decreased contact angles of PDMS (103.4° ± 0.5°, 37 °C) to 20PIPAAm-PDMS (98.8° ± 4.1°, 37 °C) and 40PIPAAm-PDMS (94.4° ± 3.4°, 37 °C). The slight decrease of the contact angles also support the graft of the PIPAAm.

Cell attachment and detachment assay for 20PIPAAm-PDMS and 40PIPAAm-PDMS was further investigated. PIPAAm modified TCPS, conventional temperature-responsive cell culture surfaces, was utilized for comparison. ECs were seed and cultured for 24 hours, and then, temperature was decreased to 20°C. Tables 1 shows percentage of the adhered cells on each surface when the number of the adhered cells onto PIPAAm-TCPS is 100%. Number of the adhered cells was counted after 24 hours cell culture (37 °C) and at 60 min after temperature decrease (20 °C). PIPAAm-PDMSs showed temperature-induced cell attachment and detachment behavior as well as PIPAAm-TCPS, although cell attachment and detachment behavior of PIPAAm-PDMSs were less than those of PIPAAm-TCPS. At the presentation, application of the PIPAAm-PDMS will be introduced as a new temperature-responsive cell culture surfaces.

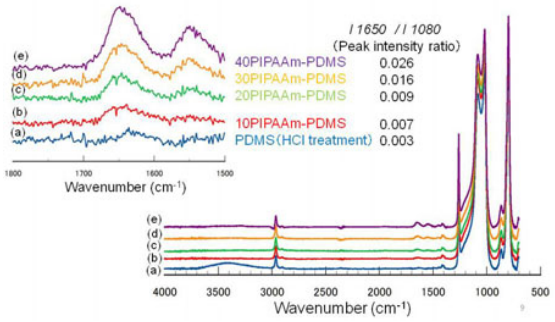

Fig. 1 FT-IR/ATR spectra of PDMS treated with HCl solution (a) and 10, 20, 30 and 40PIPAAm-PDMS (b)-(d)

Table 1 Cell attachment and detachment assay for PIPAAm-PDMS and PIPAAm-TCPS

Sample	37°C (%)	20°C (%)
20IPAAm-PDMS	90.1 ± 12.8	22.6 ± 9.1
40IPAAm-PDMS	98.4 ± 16.0	14.6 ± 6.2
PIPAAm-TCPS	100.0 ± 23.9	2.2 ± 2.4

Conclusions: PIPAAm was successfully and easily grafted onto PDMS surfaces by using EB irradiation. PIPAAm-PDMS as well as PIPAAm-TCPS also showed temperature-induced cell attachment and detachment properties. It is expected that PIPAAm-PDMS can be used as new temperature-responsive cell culture surfaces.

References:

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