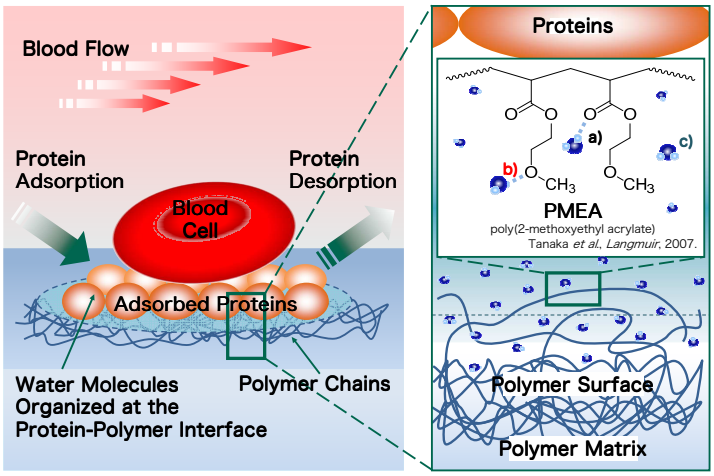
フロンティアバイオ材料のヘルスケアへの応用(4)

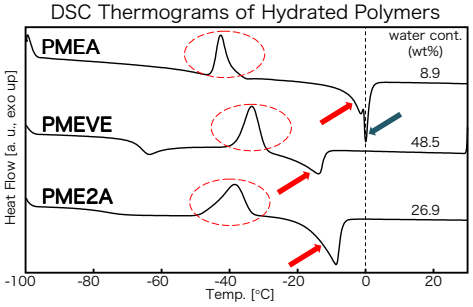
Regio選択的な開環メタセシス重合を用いた新規生体適合性高分子の精密合成

Introduction

Water Structure at Bio-interface



DSC Analysis of Water in Hydrated Polymer

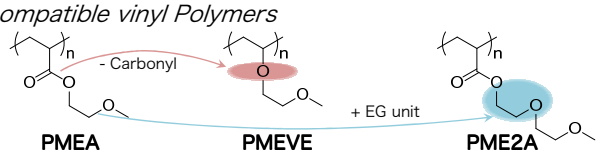


a) Non-Freezing Water
Not crystallize even at -100 °C

b) Intermediate Water
Crystallizes in heating process below 0 °C

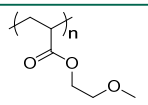
c) Free Water
Crystallizes at ca. 0 °C

Blood-compatible vinyl Polymers



Objective: Precision Polymer Synthesis for

Controls on Water Structure at Bio-interface by Precisely Controlled Polymer Architecture

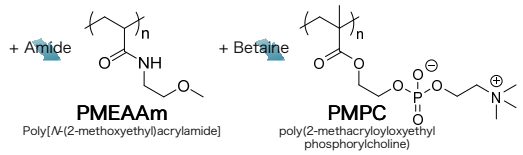


PMEA
poly(2-methoxyethyl acrylate)

- Excellent blood compatibility
- Water insoluble
- Low protein adhesion and denaturation
- Low platelet adhesion and activation
- Low toxicity, approved by FDA

Tanaka *et al., J. Biomater. Sci. Polym. Ed.*, 2010.

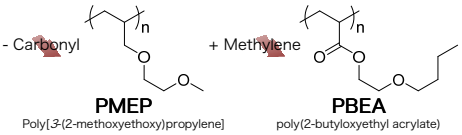
Conventional Approach using Vinyl Polymerization for Hydrophilization



PMEAAm
Poly[*N*-(2-methoxyethyl)acrylamide]

PMPC
poly(2-methacryloyloxyethyl phosphorylcholine)

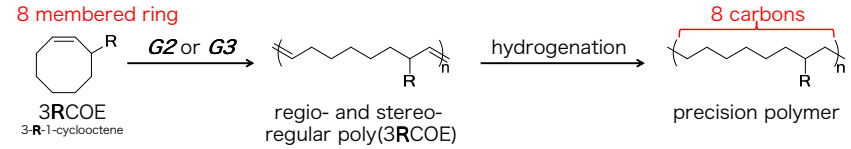
for Hydrophobization



PMEP
Poly[*3*-(2-methoxyethoxy)propylene]

PBEA
poly(2-butyloxyethyl acrylate)

A New Methodology to Control Polymer Architecture: ***Regioselective ROMP***



3RCOE
3-**R**-1-cyclooctene

regio- and stereo-regular poly(3RCOE)

precision polymer

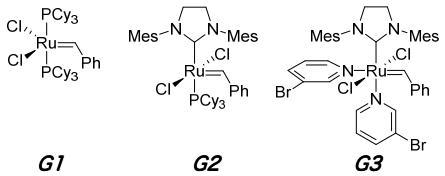
R: Me, Et, Hex, Ph, MeO, EtO, PEG, betaines, etc.

Regioselectivity >96%
near-perfect Head-to-Tail regularity
Stereoselectivity >96%
high trans- olefinic double bonds

Precisely placed branches on every 8th carbon along polymer backbone

Kobayashi *et al., JACS*, 2011.

Grubbs catalyst



G1
1st generation

G2
2nd generation

G3
3rd generation

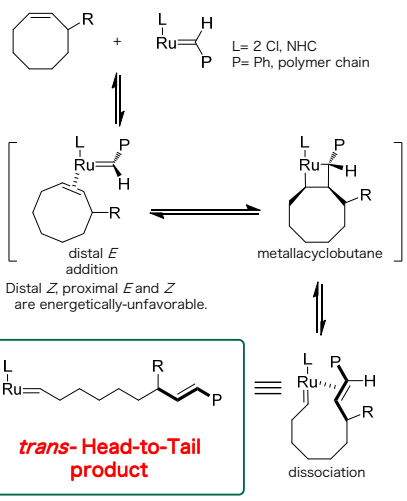
Features
- Exquisite olefin selectivity
- High catalytic activity
- **High functional group tolerance**
- Commercially available
- Reasonably stable toward H_2O and O_2
- Ease of storage and handling

and many more.

Regioselective ROMP

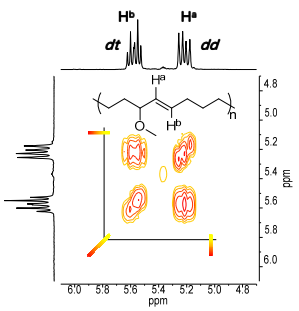
Mechanism and Analysis Data

How the regularity comes?

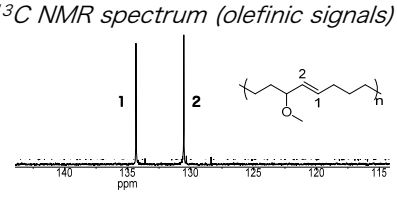


***trans*- Head-to-Tail product**

^{1}H-^{1}H 2D NMR spectrum

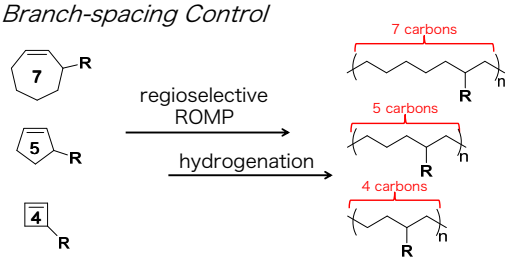


^{13}C NMR spectrum (olefinic signals)

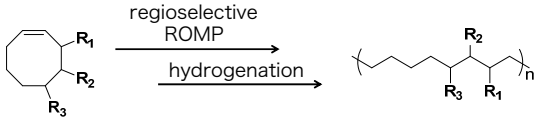


Applications

1) Branch-spacing Control



2) Sequence-specific Polymers



3) Stereo-specific Polymers