Preparation and self-assembly behavior of anisotropic polymer patchy particles

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Motivation

Analogue to polymerase chain reaction of DNA for its self-replicating

Nucleobase (reversible)
Phosphodiester backbone (irreversible)

Trivalent patchy particle

By courtesy of M. Sperling

F Naderi Mehr et al., 257th ACS Meeting Proceedings, 2019
Introduction

Inked polydimethylsiloxane (PDMS) stamps

→ Microcontact printing (µCP)
  Mono-patches

Inked polydimethylsiloxane (PDMS) stamps

180°

→ Sandwich printing
  Bi-patches
Oppositely charged patches

Melamine formaldehyde particles (IEP at pH<sub>e</sub> 8.9)
Poly(methyl vinyl ether-alt-maleic acid (M<sub>w</sub> 1980 kDa)
Polyethylenimine (M<sub>w</sub> 600-1000 kDa)

F Naderi Mehr et al., Soft Matter, 2019, 15, 2430-2438
Oppositely charged patches

SEM image of PEI mono-patch

AFM image of PMVEMA mono-patch

FL image of PMVEMA and PEI mono-patches

FL image of PMVEMA and PEI bi-patches

(Scale bars: 2 µm)

F Naderi Mehr et al., *Soft Matter*, 2019, 15, 2430-2438
Oppositely charged patches

Effect of ink concentration on the thickness of patches

<table>
<thead>
<tr>
<th>Ink Conc.</th>
<th>Mono-patchy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PEI</td>
</tr>
<tr>
<td>1 wt %</td>
<td>25 ± 3 nm</td>
</tr>
<tr>
<td>2 wt %</td>
<td>46 ± 3 nm</td>
</tr>
</tbody>
</table>

F Naderi Mehr et al., *Soft Matter*, 2019, 15, 2430-2438
Self-assembly

Mono-patchy particles (e.g. PEI)

Controlling the charge of particle and patch as well as their electrostatic forces by change of $\text{pH}_e$

<table>
<thead>
<tr>
<th>$\text{pH}_e$</th>
<th>8.9</th>
<th>10.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>% doublet</td>
<td>65 %</td>
<td>86 %</td>
</tr>
<tr>
<td>% PEI patch-particle</td>
<td>5 %</td>
<td>3 %</td>
</tr>
</tbody>
</table>
Self-assembly

Bi-patchy particles

branched

bent

linear

(Scale bars: 5 µm)
Self-assembly

Bi-patchy particles

Accidental or electrostatically directed crosslinking?

Probability rules for possible collision ways between patchy particles
Self-assembly

Increase of ionic strength

Bi-patchy

(Scale bars: 25 µm)
Self-assembly

Increase of ionic strength

Mono-patchy

Bi-patchy

F Naderi Mehr et al., to be submitted, 2019
Conclusion

Generation of zwitterionic mono- and bi-patchy particles via microcontact printing

Electrostatically induced self-assembly

Control of self-assembly by change of pH as well as ionic strength of the medium

(Scale bars: 10 µm)