Innovative block copolymers for next generation directed self-assembly

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Introduction

- **What is HORIBA?**
  - HORIBA is one of major companies of analytical equipment and flow controller in Japan.
  - **Segment**
    - Automobile, Medical, Environmental, Science, Semiconductor

- **Horiba STEC**
  - HORIBA STEC is the subsidiary company specialized in the semiconductor segment in HORIBA.
  - We have started R&D of advanced technology, and our major target is DSA material.

- **DSA(Directed Self-Assembly)**
  - DSA is next generation lithography technology.

**Experiments**

**Polymerizing method of BCPs**

- We polymerize the standard BCP of Mw 30,000 and the various “high-chi” BCPs.

- **High-chi BCPs**
  - A block 
  - B block
  - Repulsive force between the variety ingredient → Micro-phase separated structure is formed.
  - Living anionic polymerizing method
  - Precise molecular design possible

- **Precise molecular weight control**
  - We can make various polymers with anionic polymerization.

**Results & Discussion**

**Performance of BCPs**

- **High-chi BCP**
  - (A)m-b-(B)n
  - Mw=9,000
  - PDI=1.09
  - m=57/n=43
  - Lamellar
  - hp=7.5nm

- **Cross-sectional SEM image**
  - 7.5nm
  - 200nm
  - 100nm

- **High-chi Standard BCP**
  - Pre-Pattern
  - BCP Coat
  - Pattern
  - By courtesy of NISSAN CHEMICAL INDUSTRIES,LTD.

**Conclusion**

- Phase separation of 5.5nm hp is successfully measured by SAXS with our original BCP, and micro pattern of 7.5nm hp was observed on the guide pattern.
- Our original materials give impact on DSA patterning, and difficulty of HVM of BCP is overcome by our production technology.

- **Other BCPs**
  - *m* = 9,000
  - Mw/Mn (PDI) = 1.05
  - 10.4nm
  - 7.9nm

**Problems and Concept**

- 14nm hp is limited with conventional BCP (PS-PMMA).
- Innovative BCPs is needed to form less than 14 nm hp of micro pattern.
- Mass production is difficult for anionic polymerization.

**Purposes**

- To supply “high-chi” BCPs which micro pattern can be formed.
- Establishment of higher volume production of BCPs using advanced living anionic polymerizing method.