

DESIGN OF SELF-HEALING SILOXANE-BASED NANOMATERIALS

Atsushi Shimojima^{1,2}

¹ Department of Applied Chemistry, Waseda University, Tokyo, Japan; ² Kagami Memorial Research Institute for Materials Science and Technology, Waseda University, Tokyo, Japan
(corresponding author: shimojima@waseda.jp)

ABSTRACT:

Siloxane-based materials have many applications because of their high chemical and thermal stability. Precise control of the nanostructure is a promising approach to create new functional materials. In this paper, our recent studies on the design of self-healing siloxane-based nanomaterials are presented. The first topic is the lamellar silica–surfactant nanocomposite thin films that exhibit crack-healing ability. The films were prepared by evaporation-induced self-assembly using a cationic surfactant. Cracks with submicrometer widths were spontaneously healed via lateral expansion of the film upon humidity increase.¹ However, the types of the cracks that can be healed were limited. To address this issue, lamellar organosiloxane–surfactant thin films were prepared using bis-silylated organosilane precursors.² Various cracks including those formed by indentation and bending were successfully healed upon humidity increase. The enhanced crack-healing ability was probably due to the relatively high flexibility of the organosiloxane networks. Importantly, interlamellar cross-linking by the addition of bis-silylated organoalkoxysilanes with long organic spacers resulted in the increase in the nanoindentation hardness and adhesion to the substrate, with retention of the self-healing ability. These findings will contribute to the design of self-healing coatings. The second topic is design of self-healing silicone-based elastomers using cage siloxanes with a distorted double-three-ring (D3R) structure or silylated cage germanoxanes containing fluoride anions both as cleavable cross-linkers. The elastomers were prepared by the hydrosilylation reactions of Si–H or vinyl-terminated polydimethylsiloxanes (PDMS) with the cage compounds. Adhesion of the cut gel was observed after the treatment under humid conditions, which was attributed to the cleavage of the D3R cages or germanoxane cages to induce the formation of new Si–O–Si bonds between the cut surfaces.

References

- 1- Itoh S, Kodama S, Kobayashi M, Hara S, Wada H, Kuroda K, Shimojima A (2017) ACS Nano 11: 10289-10294
- 3- Kodama S, Miyamoto Y, Itoh S, Miyata T, Wada H, Kuroda K, Shimojima A (2021) ACS Appl. Polym. Mater. 3: 4118-4126