XX International Sol-Gel Conference
August 25-30, 2019, St. Petersburg, Russia

Adhesive properties of water-soluble polysilsesquioxanes containing ammonium, mercapto, and vinyl groups in side-chains

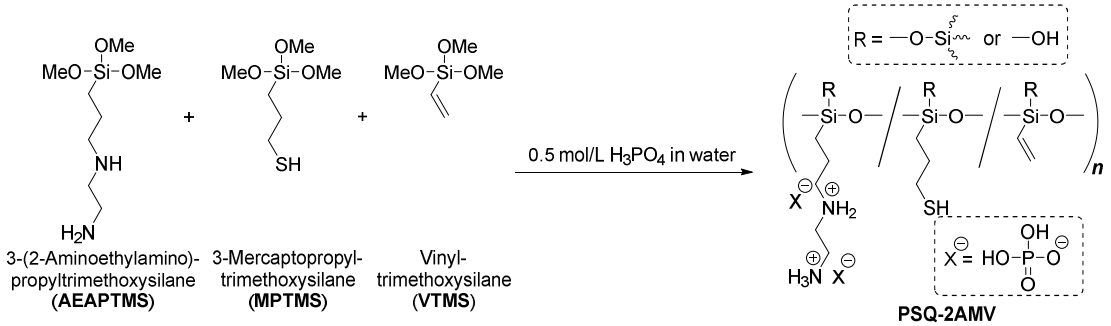
Kento Oshima[1] and Yoshiro Kaneko[1*]

Abstract

The adhesives are mainly classified into drying adhesive, chemical adhesive, and hot-melt adhesive by solidification methods. Although many adhesives have been developed, most adhesives consist of the organic polymers, which can be applied to all types of adhesives described above. Conversely, cement and water glass are practically used as inorganic adhesive, and have properties of excellent heat resistance, durability, and adhesion between inorganic materials. However, because general inorganic materials are poor solubility, "drying adhesive" with excellent storage stability are limited.

So far, we have successfully prepared water-soluble silsesquioxane copolymer containing ammonium and mercapto side-chain groups (**PSQ-AM**), which act as adhesives for inorganic materials such as stainless steels and glasses, by the hydrolytic polycondensation of a mixture of 3-aminopropyltrimethoxysilane (APTMS) and 3-mercaptopropyltrimethoxysilane (MPTMS) using HCl in water/methanol (1:19 v/v) mixed solvent.[1] However, this copolymer could not maintain adhesiveness at 150 °C. It is presumed that **PSQ-AM** could not endure the strain derived from the temperature change in the adherends with different thermal expansion coefficients, *i.e.*, a stainless steel and a glass, because this copolymer has a rigid structure.

Therefore, in this study, slightly flexible structure and loose cross-linked structure were introduced into the aforementioned PSQ to develop inorganic drying adhesives maintaining adhesiveness even at high temperature. To prepare such PSQ, instead of APTMS used in **PSQ-AM** preparation, 3-(2-aminoethylamino)propyltrimethoxysilane (AEAPTMS) as an organotrialkoxysilane containing longer alkyl chain was used. In addition, vinyltrimethoxysilane (VTMS) was also included as a starting material. The hydrolytic polycondensation of a mixture of AEAPTMS, MPTMS, and VTMS was performed using aqueous phosphoric acid (Scheme 1). The resulting terpolymer (**PSQ-2AMV**) was soluble in water. The stainless steel plate and the glass plate adhered using aqueous **PSQ-2AMV** solution were not peeled off even at 200 °C. Moreover, copolymers (**PSQ-2AM** and **PSQ-2AV**) were prepared from AEAPTMS-MPTMS and AEAPTMS-VTMS mixtures, respectively. The stainless steel plate and the glass plate adhered using an aqueous solution of a **PSQ-2AM**-**PSQ-2AV** mixture were also not peeled off at 200 °C.



Scheme 1. Preparation of water-soluble PSQ adhesive containing ammonium, mercapto, and vinyl groups in side-chains (**PSQ-2AMV**).

Reference

1. Y. Kaneko, Japanese Patent Application No. 2017-161682 (Aug. 25, 2017)

[1]Graduate School of Science and Engineering, Kagoshima University, 890-0065, Kagoshima, Japan