

Original Article

Chuang Ma, Sim Yee Chin*, Yue Zhang, Suriati B. Ghazali and Hengqiang Zhang

Transparent poly(methyl methacrylate-butyl acrylate-hexafluorobutyl methacrylate) for conservation of stone relics: synthesis and test

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Abstract: A transparent poly(methyl methacrylate-butyl acrylate-hexafluorobutyl methacrylate) stone relics protective material was synthesized using one-pot method. The synthesized polymer was coated on the surface of the stone samples or glass plates. SEM was used to observe the micromorphology of pristine stone and stone covered polymer coating samples. Physical properties of polymer coatings were characterized by FTIR, XRD and TGA-DSC. The conservation properties of polymer coatings were investigated by testing adhesion, transparency, hydrophobicity, mass loss rate and appearance of the simulated stone relics after freeze–thaw, UV irradiation and acid aging processes. Results show that poly (MMA-BA-20.04 %HFMA) outperformed the others with water contact angle remained 108.23°, 109.34° and 106.96° as well as the change of chromaticity difference values of 0.79, 0.02 and 0.08, after freeze–thaw, UV-aging and acid-aging processes, respectively. All these data indicate that the as-synthesized polymer could potentially use in conservating the stone relics due to its superior hydrophobicity, transparency, anti-acid and anti-UV aging properties as well as durability for freeze–thaw.

1 Introduction

Stone is widely used in construction, sculpture and decoration of temples, palaces and other commemorative buildings in ancient times. Stone sculpture is a kind of handicraft that utilizes sandstone as the raw material, owing to its specific properties that make it easy to engrave and preserve. Similar to paper books, bamboo slips and silk, these stone relics carried numerous cultural information.^{1,2} The information carried by stone heritages provides tangible factual evidence for ancient social development, such as human civilization history. However, the material deteriorations of the heritage are still an open issue as they are exposed to the outdoor environment and untransportable.³ There are many known factors that can affect the aesthetic of the stone relics; these include the composition and physical structure, temperature fluctuation, air contaminant, water, propagation of microorganisms and destruction by human beings.^{1,4} It is proven that the water-related deterioration is one of the most important factors for stone decay, including the fluctuations in temperature and freeze–thaw.⁵

This deterioration process can be delayed by introducing various protection methods. The uses of chemical materials to coat stone relics are an effective method to keep water away from stone relics. Nevertheless, these chemical materials must possess specific properties before they can be used as the protective coating to maintain their physical and chemical stability of the stone, such as, compatibility, transparency, hydrophobicity, anti-weathering, reversibility with the surface, non-toxicity and other properties for easy synthesis, low cost maintenance and minimum environmental impact.⁶

Inorganic material, such as $\text{Ca}(\text{OH})_2$ possesses good compatibility with stone, which can improve permeability and anti-aging properties of the coating.^{7,8} However, inorganic material may form hard shell on stone surface, which

*Corresponding author: **Sim Yee Chin**, Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuhr Persiaran Tun Khalil Yaakob, 263000 Kuantan, Pahang, Malaysia, E-mail: chin@ump.edu.my

Chuang Ma, Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuhr Persiaran Tun Khalil Yaakob, 263000 Kuantan, Pahang, Malaysia; and School of Chemistry and Chemical Engineering, Hebei Minzu Normal University, 067000, Chengde, Hebei, China

Yue Zhang and Hengqiang Zhang, School of Chemistry and Chemical Engineering, Hebei Minzu Normal University, 067000, Chengde, Hebei, China

Suriati B. Ghazali, Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuhr Persiaran Tun Khalil Yaakob, 263000 Kuantan, Pahang, Malaysia