Journal of Dental Sciences 20 (2025) 1999–2001

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journal homepage: www.e-jds.com

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Effects of poly (methyl methacrylate) particle size in dental glaze on viscosity and glossiness

KEYWORDS
Dental glaze;
PMMA;
Viscosity;
Particle size;
Zirconium

The surface of natural teeth was covered by hard enamel, which primarily protected the teeth from wear during the mastication process.[1] Consequently, the surface of dental ceramic restorations was coated with a glass-like dental glaze to simulate the enamel of natural teeth. Dental glaze formulations mostly consisted of glass powder, sintering aids, deionized water, oil, organic interface modifiers and an additional coloring agent. In clinical applications, dental glaze was prepared by mixing powder and liquid before being applied to the surface of ceramic restorations, forming a thin film after high-temperature sintering.[2] However, the viscosity of dental glaze affected the uniformity of the coating.[3] Therefore, reducing viscosity and improving uniformity remained key challenges. Previous studies demonstrated that pigment aggregation influences the adhesion of dental glaze, while dispersants reduce the viscoelasticity of colloids and increase the flowability of the dental glaze.[4] Therefore, this study initially investigated the effects of dispersants with different particle sizes on the viscosity and glossiness of dental glaze.

The dental glaze composition used in this study primarily consisted of 60 wt% glass powder (Schott Glaswerke AG, Mainz, Germany), 5 wt% ammonium acrylates copolymer (THE.YIH.CHEMICAL, Taichung, Taiwan), 5 wt% defoaming agents (THE.YIH.CHEMICAL), and 30 wt% deionized water. Additionally, 5 wt% of poly (methyl methacrylate) (PMMA, Anchem Technology Corporation, Taichung, Taiwan) with three different particle sizes was used as a dispersant: 4 μm (PM04), 8 μm (PM08), and 12 μm (PM12). The surface morphology and elemental composition were analyzed using a field emission scanning electron microscope (SM-6700F, JEOL, Tokyo, Japan) and energy-dispersive X-ray spectroscopy (EDS, JEOL). The viscosity was measured using a rheometer (Physica MCR 101, Anton Paar, Graz, Austria). Finally, the three groups were uniformly applied to zirconia incisor crowns and sintered in a high-temperature furnace (Duotron 3000, DuoTron PRO, B&D Dental Technologies, Johnstown, CO, USA).[5] The temperature was increased at a rate of 45 °C/min until reaching 850 °C.

The results showed that the dental glaze primarily consisted of 15 μm glass particles (Fig. 1A). The surface elemental composition of the pure glass was arranged in proportion, with the main elements being Si, Na, Al, K, Ca, and Ba (Fig. 1B). The viscosity-shear strain curves for all three groups indicated that viscosity decreased as the shear rate increased (Fig. 1C). Under shear rates of 1 s/1 and 500 s/1, PM04 exhibited the highest viscosity, followed by PM08 and PM12 (Fig. 1D). This suggested that an increase in poly (methyl methacrylate) particle size reduced viscosity. The final coating on the tooth surface demonstrated that PM08 and PM12 produced a more uniform and glossier surface compared to PM04 (Fig. 1E). Therefore, adjusting the particle size of the dispersant in the dental glaze

https://doi.org/10.1016/j.jds.2025.03.015

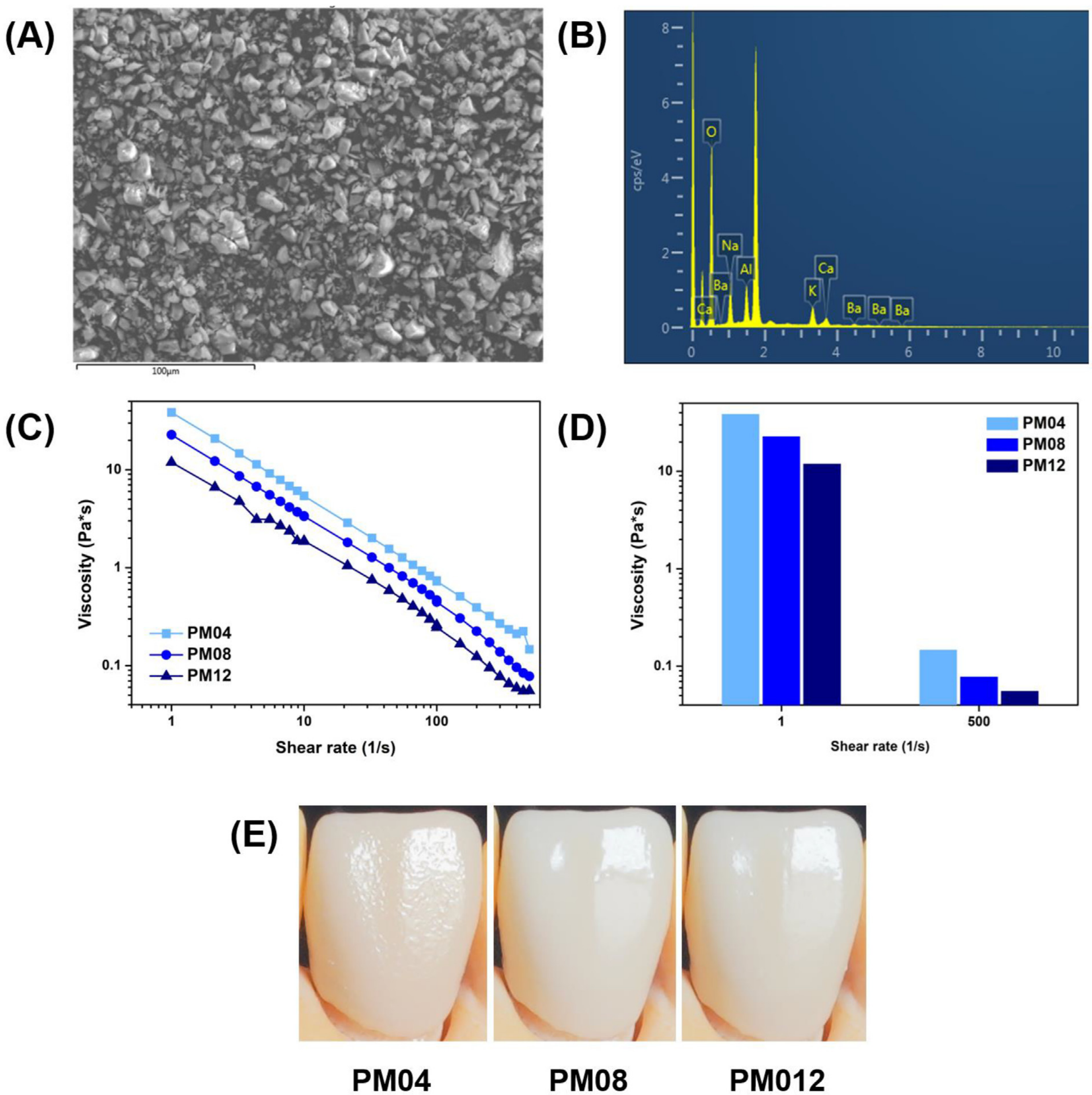

Figure 1 Effects of the main components of dental glaze and poly (methyl methacrylate) particle size on viscosity and glossiness. (A) Surface morphology of main glass powders in dental glaze. (B) Surface elements of main glass powders in dental glaze. (C) Viscosity-shear strain rate diagram of poly (methyl methacrylate) particle size in dental glaze. (D) Viscosity value of glaze at the shear strain rate of 1 s-1 and 500 s-1. (E) Glossiness results of different dental glaze applied on zirconia incisor crown.

effectively reduced viscosity and improved the glossiness of the ceramic restoration surface. However, this study was limited to controlling the size of the dispersant particles. Further research is needed to explore whether different types or concentrations of dispersants could enhance the dispersion properties of dental glaze. Future studies will continue to refine manufacturing strategies for dental ceramic restorations.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

None.

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Yung-Kang Shen
School of Dental Technology, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan
Department of Dental Biomaterial, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia

I-lin Lu
School of Dental Technology, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan

Chien-Wen Huang
Tung Chun Dental Clinic, Taipei, Taiwan
School of Dentistry, College of Oral Medicine, Chung Shan Medical University, Taichung, Taiwan

Wei-Chun Lin*
School of Dental Technology, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan
Department of Dentistry, Wan-Fang Hospital, Taipei Medical University, Taipei, Taiwan

*Corresponding author. School of Dental Technology, College of Oral Medicine, Taipei Medical University, No. 250, Wu-Xing Street, Taipei, 11031, Taiwan.
E-mail address: weichun1253@tmu.edu.tw (W.-C. Lin)

Received 11 March 2025
Final revision received 13 March 2025
Available online 26 March 2025