**Controllable Preparation of Multi-scale Silica Using High-gravity Technology Combined with Spray Drying Process for Dental Restoration Application**

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**Abstract**

Resin-based composites have been frequently used in dental restoration because of their outstanding esthetics, mechanical performances, biocompatibility, and clinical operability. The particle size, dispersity and structure of inorganic filler are decisive for the properties of resin composite. In this study, monodisperse silica nanoparticles (MSNPs) with a controllable diameter were efficiently prepared with high-gravity technology in an internal circulation rotating packed bed (ICRPB), and then the spray-drying technology was used to efficiently construct micron-scale nanoparticle clusters (MSNCs). The results indicated that the particle size, morphology and dispersion of silica nanoparticles were influenced by the rotating speed of ICRPB and the concentration of reactants. Compared with traditional stirred tank reactor, the hydrolyzation process in ICRPB had one-third descent in reaction time and the size of MSNPs dramatically decreased. The prepared nanodispersions could be stably conserved for over 12 months without any changes in particle size, transparency and monodispersity. After being modified by the silane coupling agent, the MSNPs were mixed with the resin matrix to preparing the resin composites. The effects of filler content, particle size and structure on mechanical performances were further examined. It could be found that the mechanical properties of composites were significantly improved with the increased filler content from 40 to 70 wt.%, and enhanced first and then dropped with increasing particle size when the MSNPs were used as the fillers. Due to the excellent dispersity, the maximum content of MSNPs was 30% higher than that of commercial silica nanoparticles with the same size, thereby resulting in better properties of the composites. Furthermore, compared with silica microparticles with the similar average size and the MSNPs, the MSNCs showed an obvious improvement in flexural strength and compressive strength due to its steady porous structure inside, which was capable to produce a stronger interlocking between organic resin and inorganic fillers. This method could be applied to the preparation of hydroxyapatite, zinc oxide and zirconia nanoparticle clusters, and will provide a new idea for the controlled preparation of high-performance multifunctional fillers for dental restorative resin composites.