Radiopaque flame-made Ta_2O_5/SiO_2 nanoparticles with controlled refractive index and transparency

Heiko Schulz[a] (speaker), Lutz Mädler[a], Sotiris E. Pratsinis[a], Peter Burtscher[b], Norbert Moszner[b]

[a]Particle Technology Laboratory, Department of Mechanical and Process Engineering, Swiss Federal Institute of Technology Zurich, CH-8092 Zurich, Switzerland
[b]Ivoclar Vivadent AG, FL-9494 Schaan, Liechtenstein

Mixed Ta_2O_5-containing SiO_2 powders with high specific surface area, controlled refractive index, transparency and crystallinity were prepared by flame spray pyrolysis as fillers for dental composites. The production rate ranged from 6.7 – 100 g/h in a lab scale reactor. The effect of the Ta-precursor, the solvent, the total metal concentration and the Ta-content were studied by nitrogen adsorption, x-ray diffraction, light microscopy, HRTEM, DIFTS analysis, as well as the composite transparency within a polymer matrix of dimethylacrylate for dental restoration applications. Filler properties such as transparency, crystallinity and Ta-dispersion in the SiO_2 matrix altered the composite performance. Ta_2O_5 crystallites and a low Ta-dispersion within the SiO_2 matrix decreased the filler and composite transparency. Powders with identical specific surface area, refractive index and Ta_2O_5-loading (24 wt%) showed a wide range of composite transparencies from 33 – 78 % depending on filler properties. Fillers with an amorphous structure, a high Ta-dispersion and a matching refractive index with the polymer matrix showed the highest composite transparency of 86 % for a 16.5 wt% filler loading including 35 wt% Ta_2O_5 giving an optimal radiopacity.