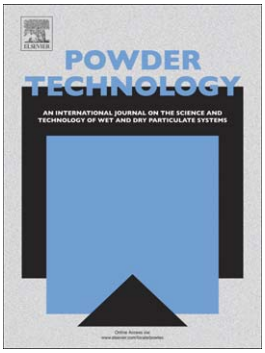

Sub-oxide passivation of silicon nanoparticles through rapid mechanical attrition

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Sub-oxide passivation of silicon nanoparticles through rapid mechanical attrition.

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Abstract

Inks produced from the inclusion of silicon nanoparticles in a suitable polymer present the best opportunity for true printability of silicon with purely additive patterning under ambient conditions with no thermal post-processing. For large scale production of silicon nanoparticles, the most appropriate methods are vapor phase synthesis by pyrolysis of silane or the milling of bulk material. In this work, we compare low energy ball milling using zirconium ball with a rapid attrition of bulk silicon using a high-energy vibratory disk mill and show that the later process passivates the further growth of surface oxide on the nanoparticles. XPS results indicated a significant surface oxidation for silicon nanoparticles produced using low energy ball milling relative to the rapid attrition using the high-energy vibratory disk. HRTEM shows a pronounced surface oxide thickness on the nanoparticles produced via low energy ball mill. This surface oxide resulted in charge trapping and drastically effected the carrier transport of the compacted powder. The powder produced from the high-energy mill, in contrast, does not show a distinct surface oxide layer under HRTEM and the carrier transport was generally ohmic.

Keywords: Nanoparticles; Attrition; surface oxidation; carrier transport**.**

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