Production of Nano-composite Si-M powders by plasma spraying for next generation lithium ion batteries

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We have attempted plasma spraying to produce nano Si powders for lithium ion batteries at the industrial compatible throughputs. Several 100 nm nano-composite powders are typically produced from metallurgical grade Si powders, and its improved battery capacity has been revealed. When doped with >10 mol% Ni, several SiNix alloy particles, that are the congruent phases with relatively high melting temperature in the Si-Ni binary system, were produced. The battery performance of these powders was not as good as that with Si powders only. In contrast, at 5 mol% Ni addition, NiSi2 phase was only detected apart from Si. Importantly, the battery performance was improved. Since NiSi2 is an incongruent phase that forms through peritectic reaction, it plausibly nucleates heterogeneously on surface of Si particles that nucleate in advance. In fact, TEM analysis revealed that NiSi2 was present on Si surface not as individual particles. Therefore, such a composite structure, not a simple mixture of foreign particles, is considered to improve the battery performance possibly by increasing the particle mechanical integrity as well as the electric conductivity of the electrode.

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