Synthesis of nanoporous silicon by recycling of waste iron slag and its application to lithium ion battery anodes

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The development of new processes that generate high value-added products from industrial waste has attracted great attention as a technical breakthrough from both an economic and an environmental point of view. Iron slag, one type of ferrous slag produced in the iron making process in the 270-320 million tons range, has a high content of SiO2 (~35 wt%), which makes iron slag a potential source of silica for various silicon-based materials. In this study, we have developed a facile approach to synthesize nanoporous silicon derived from waste iron slag for high performance Li-ion battery anodes. Simple acid leaching of iron slag leads to the generation of nanopores, and subsequent magnesiothermic reaction with sodium chloride convert silica to silicon without collapse of structure. The resulting nanoporous silicon contains micro-sized particles composed of nanosized primary silicon particles, and it has a surface area of 438 m^2/g. Owing to three-dimensionally interconnected and the highly porous structure with small crystallite size, the resulting nanoporous silicon exhibits excellent electrochemical properties as an anode of Li-ion batteries.