# Large-scale synthesis of crystalline-amorphous Silicon nanoparticles as anode material for high-performance lithium ion batteries

Yu Zhou, Huajun Guo, Jiexi Wang, Zhixing Wang, Xinhai Li
*School of Metallurgy and Environment, Central South University, Changsha, Hunan, 410083, China*

*09zhouyu@163.com*

Silicon (Si) holds great promise as anode material because of its high gravimetric capacity (3570 mAh $g^{-1}$) and volumetric capacity (8322 mAh $cm^{-3}$) at room temperature.[1, 2]. However, the large volume change of Si anode during cycling blocks the way for the practical applications. Both crystalline Si (c-Si) and amorphous Si (a-Si) can store $Li^+$ ions with similar specific capacity[3-5]. The combination of c-Si and a-Si could be a good strategy to achieve an ideal anode material. Inspired by these preliminary works, in order to improve the performance of silicon, the amorphous silicon is introduced to crystalline nanoparticles to form a homogenous amorphous-crystalline coexisting domains (c-a-Si NPs) by chemical vapor deposition in fluidized bed reactors (FBR) for the first time, which is widely utilized for the photovoltaic industry because of the energy and time saving capabilities. In the prepared Si material, the a-Si phase component with isotropic expansion prevents the fracture of the nanoparticles and the c-Si phase improves electronic conductivity of the nanoparticles.

Fig. 1(a) shows the XRD pattern of the prepared c-a-Si NPs. All peaks can be indexed to the characteristic peaks of Si. In Raman spectroscopy (Fig. 1b), the intensity of crystalline silicon peak (520 $cm^{-1}$) is weakened and shifted to lower wavenumbers, suggesting the loss of the long range order of Si-Si bonds. The SEM image in Fig. 1(c) shows that the c-a-Si NPs have a spherical shape with diameters of 30-80 nm. TEM image in Fig. 1(d) also displays the typical spherical structure at a high yield. HRTEM image shows that the crystalline phase is embedded in the amorphous phase.

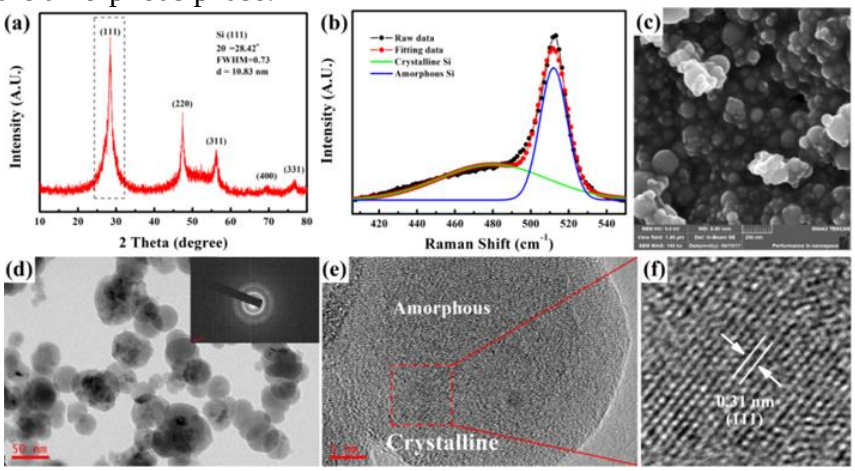


Fig. 1 (a) XRD patterns and (b) Raman spectra of c-a-Si NPs; (c) SEM image and (d-f) TEM images of c-a-Si NPs.

**References:**

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