
# Magnesiothermic reduction of 3D printed porous silica monoliths to silicon as anode material for Li-ion batteries

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Since Li-ion batteries are nowadays used in most electronic devices the research remains highly active to improve their operation hours and charging time. Silicon has been extensively investigated as anode material in replacement for graphite due to its 10 times higher specific capacity and safer lithiation voltage. However, the main downside on silicon as anode material is it poor cyclability. During the charge and discharge, the intercalation of Li ions results in volume expansion causing structural damages. To address this issue, the development of porous silicon has been regarded as a promising solution to accommodate the volume expansion and prevent material pulverization. Therefore, we propose to convert 3D printed hierarchically porous silica ($SiO_2$) monoliths to porous silicon (Si) through magnesiothermic reduction. First, 3D printed $SiO_2$ monoliths were obtained using a new class of functional inks based on a photoresponsive ligand on inorganic core (PLIC)[1]. This inorganic core was made of ultrasmall silica nanocages of about 10 nm in size[2]. Then the magnesiothermic reduction, following the main reduction reaction: SiO2 + 2Mg → Si + 2MgO, was performed by placing Mg powder next to the $SiO_2$ monolith before processing a thermal treatment between 500-650°C for few hours under inert atmosphere (Figure 1). Finally, the resulting MgO was easily removed by HCl etching from the as-obtained porous Si monolith.

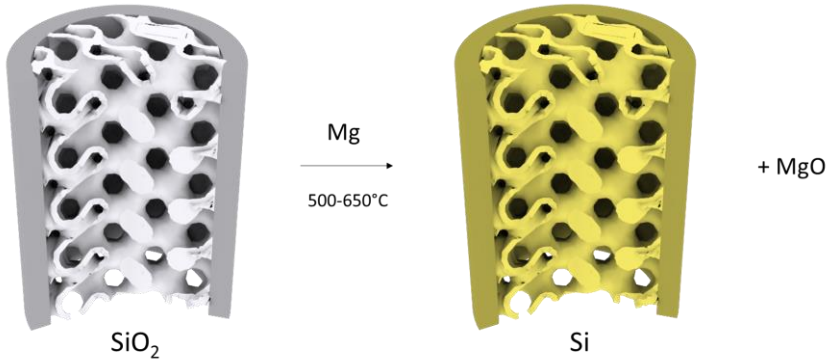


*Figure 1: Illustration of the magnesiothermic reduction of porous $SiO_2$ monolith to porous Si monolith*

## References

[1] T. Aubert, J.-Y. Huang, K. Ma, T. Hanrath, U. Wiesner, *Nat Commun* **2020**, *11*, 4695.
[2] K. Ma, Y. Gong, T. Aubert, M. Z. Turker, T. Kao, P. C. Doerschuk, U. Wiesner, *Nature* **2018**, *558*, 577–580.