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## A facile one-pot solution-phase route to synthesizing anovel composite hierarchical hollow structure: W18O49/WO2 Hollow Nanourchins

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To date, nanostructuredtungsten oxides with a variety of stoichiometries, such as WO3, WO2.9, W18O49, and WO2, have been prepared, because they are promising candidates forapplications such as gas sensors, photocatalysts, electrochromic devices, andfield emission devices. Among them, W18O49 and WO2 have been widely studied dueto their outstanding chemical sensing, catalytic, and electron emissiveproperties. Here we report, for the first time, a one-pot solution-phase routeto synthesizing a novel composite hierarchical hollow structure without addingcatalysts, surfactants, or templates. The products, consisting of a WO2 hollowcore sphere surrounded by a W18O49 nanorod shell (yielding a sea urchin-likestructure), were generated as discrete structures via Ostwald ripening. To ourknowledge, this type of composite hierarchical core/shell structure has notbeen reported previously. The morphological evolution and the detailed growthmechanism were carefully studied. We also demonstrate that the size of thehollow urchins is readily tunable by controlling the reactant concentrations.Interestingly, although bulk tungsten oxides are weakly paramagnetic ordiamagnetic, the as-prepared products show unusual ferromagnetic behavior atroom temperature. The urchin structures also show a very highBrunauer-Emmet-Teller (BET) surface area, suggesting that they may potentiallybe applied to chemical sensor or effective catalyst technologies.

**Keywords:** tungsten oxide, nanomaterial, hierarchical stcuture

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## Surface modification for block copolymer nanolithographyon gold surface

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Block copolymer lithographyhas attracted great attention for emerging nanolithography since nanoscaleperiodic patterns can be easily obtained through self-assembly process withoutconventional top-down patterning process. Since the morphologies of self-assembledblock copolymer patterns are strongly dependent on surface energy of asubstrate, suitable surface modification is required. Until now, the surfacemodification has been studied by using random copolymer or self-assembledmonolayers (SAMs). However, the research on surface modifications has beenlimited within several substrates such as Si-based materials. In present study, we investigated the formation of block copolymer on Au substrate by $O_2$ plasma treatment with the SAM of 3-(p-methoxy-phenyl)propyltrichloro-silane [MPTS, $CH_3OPh(CH2)_3SiCl_3$]. After $O_2$ plasma treatment, the chemical bonding states of the surface wereanalyzed by X-ray photoelectron spectroscopy (XPS). The static contact anglemeasurement was performed to study the effects of $O_2$ plasma treatment on the formation of MPTS monolayer. Theblock copolymer nanotemplates formed on Au surface were analyzed by scanningelectron microscopy. The results showed that the ordering of self-assembledblock copolymer pattern and the formation of cylindrical nanohole arrays wereenhanced dramatically by oxygen plasma treatment. Thus, the oxidation of goldsurface by $O_2$ plasma treatment enables the MPTS to form the monolayer assembly leadingto surface neutralization of gold substrates.

**Keywords:** block copolymer, lithography, gold