Light-Induced Chemical Modification in Nanostructued Co_3O_4

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The morphology of nano-scaled materials recently contains nanotube and nanoparticle, which is used for the important component of nanodevice for the large surface area and novel electronic character. Co_3O_4 is the ferromagnetic metal oxide during the driect heating Co foil in air. The route of chemical modification is devoted to study for its potential and multi-function application. Scanning photoelectron microscopy (SPEM) is able to probe into the electronic structure with the chemical mapping image. This work is completed in SPEM at NSRRC 09A1 beam line.

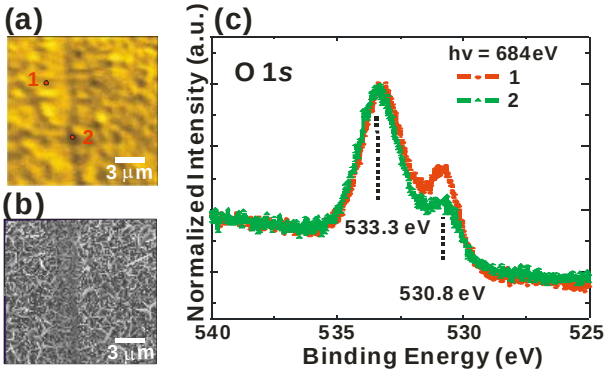

Figure 1. (a) and (b) are the top-viewed SPEM and SEM images around the same area. (c) O 1s spectra from as-grown area (point 1) and laser-modified area (point 2).

Figure 1(a) and 1(b) show the SPEM and SEM image of Co_3O_4 with high laser power modification taken at the same area, respectively. Figure 1(c) shows the O 1s spectra taken from the specific point, as denoted in figure 1(a). The feature of O 1s spectra with BE 533.3 eV is attributed to surface-absorebed oxygen compound. The air-exposed cobalt oxide should contain the possible absorption about C-O, O=C-O, and H_2O. The other feature with BE 530.8 eV is assigned to the chemical composition of Co_3O_4. It is noticeable that the peak intensity with BE 530.8 eV at point 1 is higher than this at point 2. It is supposed that the decreased intensity at BE 530.8 is due to laser transfer effect from Co_3O_4 to Co.

Figure 2(a) shows the O 1s mapping image. The artificial line formed by laser is clear observed in the middle of SPEM image. Figure 2(b) shows the position-related O 1s spectra taken from a-b line. The x and y axis of the horizontal plane represent the a-b line distance and binding energy. Z-axis reflects the intensity of O 1s spectrum. The spectra are the intensity summation with 300 × 300 nm^2 area along the a-b line in the mapping image, as shown in fig. 2(a). From the previous discuss, we observe that the feature of O 1s spectrum with 530.8 eV after laser irradiation should be reduced by laser. Similar to this phenomenon, we also can see the intensity decrease at BE 531.1 eV in the laser-modified area, as denoted by the yellow circle in figure 2(a) and 2(b). Figure 2(c) is the intensity curve with BE 533.5 and 531.1 eV along a-b line. The intensity difference induced by laser is only occurred in the curve of BE 531.1 eV. The intensity with BE 533.5 eV oppositely maintains the similar intensity even though through laser irradiation area.

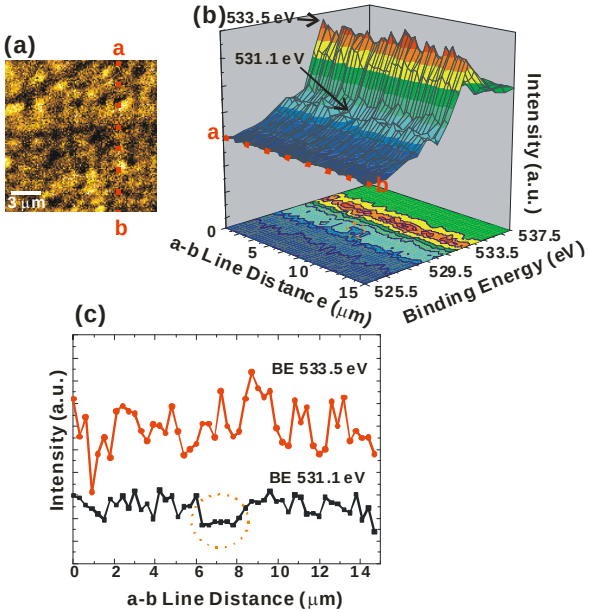

Figure 2. (a) SPEM O 1s mapping image of laser-modified Co3O4. (b) 3D surface plot of O 1s spectra along a-b line-profile. (c) The emission intensity curve of O 1s state with BE 533.5 and 531.1 eV.

In summary, nanowall Co_3O_4 can be fabricated by a simple hot-plate method. As compared with the O 1s spectra from the specific position and the lineprofile of O 1s chemical mapping, we conclude that the oxygen reduction in the chemical composition of Co_3O_4 is determined by the photochemical reaction. The simple technology of chemical modification is used as the new way to influence the chemical and physical property with high degree of control of nanostructured materials.