Chinese Chemical Letters Vol. 10, No. 12, pp. 1049-1050, 1999

XPS Study of the Oxygen on A_2BO_4-type Compounds —A New Discovery of O_{1S} Peaks

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Abstract: By means of XPS, a new O_{1S} peak which reflects the lattice oxygen on A_2BO_4-type compounds is discovered, suggesting that the lattice oxygen might have two energy states on this type of material.

Keywords: XPS, lattice oxygen, A_2BO_4-type compound.

A_2BO_4-type compounds are a kind of catalytic material which has demonstrated outstanding performance, especially in catalytic oxidation and reduction reactions[1, 2]. For this type of compounds, the existing reports suggest that the existence of oxygen in the oxide structure plays a very important role in its catalytic performance, and study on the distribution of oxygen is necessary. The analysis method, XPS, is a quite effective means for this purpose. Up to now, most studies suggest that there are two major types of oxygen on the surface of this type of compounds, that is, the adsorptive oxygen and the lattice oxygen identified to be around 531 eV and 528 eV respectively in the O_{1S} spectrum [3, 4] . Our XPS analysis of the oxygen in A_2BO_4-type structure leads us to a discovery of a new O_{1S} peak.

Experimental

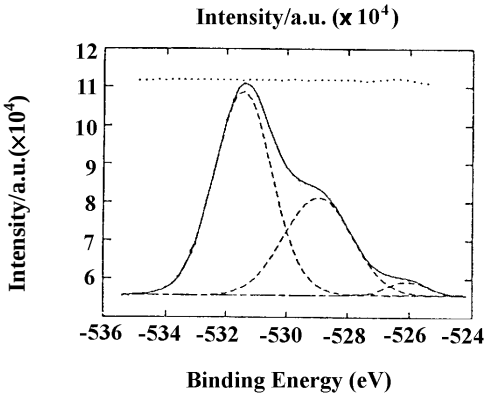
The citric acid complexometry was adopted to prepare La2BO4-type catalyst samples. D/max-2A X-ray analyzer was used to identify the composition and structure of the samples. PH1.1600 ESCA System (XPS) was used to determine the oxygen distribution on the sample surface. Prior to the experiment, the samples underwent respective pretreatment. The whole experimental process must guarantee equal operating conditions for all samples. The spectrum peak was identified with reference to carbon 284.6 eV.

Results and discussion

Figure 1 is the O1S spectrum of the sample La2CuO4 and it can be seen that there are three peaks around 531.6 eV, 529.0 eV and 526.4 eV. According to the existing conclusion 3, 4 , O1S peak of 531.6 eV and 529.0 eV should correspond to the chemical

adsorptive oxygen and the lattice oxygen respectively, whereas the O1S peak of 526.4 eV was not detected before. In consideration of its energy state, this peak has less energy than 529.0 eV. Since the O1S peak 529.0 eV corresponds to the lattice oxygen, then the peak of 526.4 eV should also reflect the lattice oxygen.

Figure 1 XPS analysis on O1S of La2CuO4



The peak 526 eV exists not only in the O1S analysis of La2CuO4 but also in those pretreated samples shown in Table 1. Therefore, the O1S peak of 526 eV, though comparatively small in quantity, does exist. So, we suggest that the lattice oxygen is present in this type of samples in two energy states.

From structural point of view, A2BO4-type compounds have laminate structure and the oxygen in AO layer and ABO3 layer must not have the same activity 5. As the structure demonstrates two different environmental conditions for the oxygen, the XPS results should reflect this structure .

Table 1 XPS analysis on O_{1S} of La_2BO_4

Sample	La_2CuO_4		$LaSrCuO_4$		La_2NiO_4		$LaSrNiO_4$	
Pretreatment conditions	373k N_2 purge one hour		373k N_2 purge one hour		573k H_2 purge one hour		573k H_2 purge one hour	
	peak(eV)	content(%)	peak(eV)	content(%)	peak(eV)	content(%)	peak(eV)	content(%)
Binding	526.4	8	526.2	12	526.6	4	526.5	6
Energy	529.0	34	528.9	35	529.2	34	529.4	30
	531.5	62	531.4	53	531.4	62	531.1	64

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Received 29 April 1999