THERMAL STABILITY OF POWDERY TIC, ZRC, CR_3C_2 AND WC ON AIR

Kudin V.G.
Kiev National Taras Shevchenko University
Volodymyrska str. 64, Kiev, 01033 Ukraine
E-mail: kudin@univ.kiev.ua

Powdery metal carbides have high hardness, so they can be used as abrasives. Thus, the goal of this study was investigation of oxidation of titanium, zirconium, chromium, and tungsten carbides on air in the range of temperatures 700-1000°C in non-isothermal modes using the derivatograph Q-1500 with the heating rates 5 and 10 K/min with simultaneous conduction of differential thermal analysis.

TiC, ZrC, Cr_3C_2 and WC of "pure" quality (99%) were used for experiment. It appeared that the particles with diameter 5-10 micron predominated in all the powders. It was established that the studied powdery TiC, ZrC, Cr_3C_2 and WC began to interact with oxygen in air at 410, 500, 900 and 545°C respectively, and further increase in temperature causes increasing their oxidation degrees. In non-isothermal process, the oxidation degrees (α) of ZrC and WC at 1000°C are equal to 100 and 60% respectively. This indicates that the studied compounds have a significant affinity to oxygen and not high thermal stability.

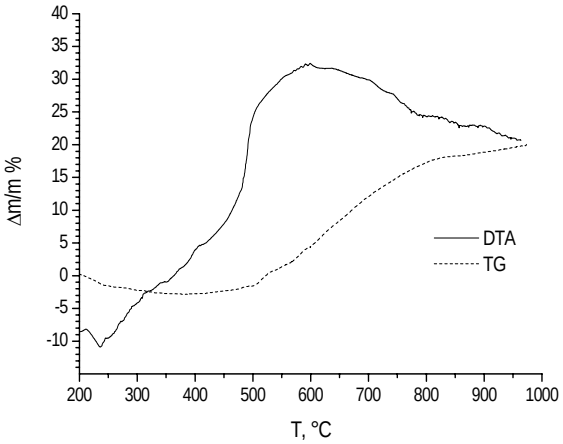
For example, the derivatogram of WC is presented in the figure. It is visible from the TG-curve that the mass increases when WC become oxidated. The transformation degrees of TiC, ZrC, Cr_3C_2 and WC calculated from TG-curves revealed their increase.

The composition of oxidation products was identified using X-ray diffractometer DRON-3. In was found that TiC, ZrC, Cr_3C_2 and WC form oxides TiO_2, ZrO_2, Cr_2O_3 and WO_3 respectively. It was important to determine the heat effects observed at oxidation of the studied substances. Accordingly to our derivatographical investigations, the oxidation processes of interaction of TiC, ZrC, Cr_3C_2 and WC with oxygen are exothermal.

Using the DTA-curves, we calculated the heat effects of oxidation processes. The coefficient of proportionality (k) between the heat effect and the area below the peak on the DTA-curve was estimated from the analogous data for the derivatographical investigations of KCl and Na_2WO_4, the melting enthalpies of which are known. Calculated values of coefficients of proportionality are 8.8 and 12 conventional units at DTA sensitivities 250 and 500, respectively. Using the areas below the peaks on the DTA-curve, we determined the heat effects that were observed during oxidation of 1 mol TiC, ZrC, Cr_3C_2 and WC, in accordance to the formula

$$\Delta H = \frac{k \cdot S}{n_i \cdot \alpha} \qquad (2)$$

where n_i is molar quantity of pure substance having been oxidized. Considering the transformation degrees of the investigated substances, we calculated the heat which would be emitted at whole oxidation of 1 mol TiC, ZrC, Cr_3C_2 and WC. These data agree with calculations using Hess' law.



Carbide	Δm_T	-ΔH, Hess' law	-ΔH, from DTA-curves
TiC	0.3377 m_s	1128.6	385
WC	0.1852 m_s	1195.7	756
Cr_3C_2	0.27 m_s	2418.4	1050
ZrC	0.038 m_s	1286.6	528