KCBraun
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## Physical Properties of Wolfram Sulfide, $WS_2$

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(See also T-359 & T-236)

According to Corleis, $(NH_4)_2WS_2$ strongly heated (geglühtes) in a stream of $SO_2$ produces $WS_2$ in porous pseudomorphs conforming to ammonium wolframate. According to I. G. patents, $WS_2$ is similarly obtained by heating ammonium parawolframate for days in an $H_2S$ stream @ 300-400° C. The gray metallic shining crystals are pseudomorphous $NH_4$ - parawolframate and give a 20% higher yield than normal hexagonally crystallized $WS_2$, when used as catalyst in pressure hydrogenation.

$WS_2$ crystallizes hexagonally. The elementary cell contains 2 molecules $WS_2$, the edges are a = 3.18 Å, C = 12.5 Å, and the parameter is 1/8 or more likely 3/8. The crystal structure is the same as $MoS_2$.

$WS_2$ loses its sulfur in an electric furnace at very high temperatures. At 1100° C in vacuum it is still not decomposed. At 1200° C it loses 60% of its sulfur in 2 hours and at 2000° C is completely desulfured in a short time.

$WS_2$ is reduced by $H_2$ from 800° C up, and after heating for 7 hours all S is evaporated as $H_2S$. The reaction equilibrium $WS_2 + 2\ H_2 \rightleftharpoons W + 2\ H_2S$ is determined only by the partial pressures of $H_2$ and $H_2S$ and is independent of external pressure. The extrapolated limiting values of this ratio are,

at 795° C: 0.0140
" 895° C: 0.02634
" 985° C: 0.0420
" 1065° C: 0.0740

The heat of formation of $WS_2$ is calculated therefrom as about 73.4 Kcal between 800°C and 1065°C. $WS_2$ does not form a phase poorer in sulfur.

Wolfram-trisulfide, $WS_3$, is a black powder, which is decomposed into $WS_2$ and S by heat. It is not fully reduced by either water gas or hydrogen.

Investigations into dehydrogenation of cyclohexane on $WS_2$ showed a low dehydrogenating effect of the catalyst precipitated on $SiO_2$, compared to $MoS_2$ on $SiO_2$-gel. $MoS_2$ without $SiO_2$-gel was still better; a slight $CH_4$ formation at the beginning was attributed to residual $MoS_3$. $Cr_2O_3$ showed a 25 times greater effectiveness than $MoS_2$ catalysts.

Bruining conducted experiments on the secondary electron emission of $WS_2$. It was found that high electron emission takes place only if an electron can be raised from a filled up energy band into an energy band so high that emergence from it into vacuum is possible without supplying additional energy. $WS_2$ will give smaller yields in this than the pure metal. The compounds of electro-positive metals give lower values for d (delta), $MoS_2$ = 0.9, $WS_2$ = 0.77 - 0.85. (Delta = ratio of electron emission to electron supply.)

Work on the detector effect of small crystalline blue-green shining $WS_2$ (from wolfram powder and flower of sulfur @ 600° C and further seven hour heating to 1450° C), as well as of large metallic shining crystals with hexagon edge formation (from $WO_3$ and flower of sulfur with $K_2CO_3$ added by heating in $H_2S$ stream to 600-700° C and further 20 hour heating to 1400° C), showed an effect equal to $MoS_2$ with equal size crystals. With direct current, the direction of current flow was from point to crystal.

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