

PHYSICS

(Paper No. 46 was presented at the meeting of 1921 Paper No. 47 was presented at the 1922 meeting.)

XLVII. THE SIMPLE RIGIDITY OF A DRAWN TUNGSTEN WIRE AT INCANDESCENT TEMPERATURES

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The simple rigidity of a 10-mil drawn tungsten wire was determined at temperatures between 1800° and 2000°K. A static method was employed. By applying the same torque to both a short

length and a long length of wire,—middle portions of both lengths at the same temperature—it was possible to get the angle of twist of a section of the wire, all of which was at a uniform temperature. The torque necessary to produce the twist in the heated wire was measured by the twist in a fine cold tungsten wire of known constants. The temperatures were measured by means of an optical pyrometer of the Morse type; corrections were made for the absorption of the evacuated glass tube which enclosed the wire.

The modulus of simple rigidity for an equiaxed wire was found to be 21.7×10^{11} dynes per cm^2 at 1000°K and only 3.1×10^{11} dynes per cm^2 at 2000°K . There was a relatively small decrease in the rigidity modulus between room temperatures and 1100°K . At a temperature (1600°K) where the rigidity of the tungsten was equal to that of steel at room temperature, the elastic limit of the tungsten was, relatively, very small.

Jeffries'* work on the change of crystal structure of tungsten wire by heat-treatments at various temperatures makes it possible to draw the following conclusions from the temperature-rigidity curves of the 10-mil tungsten wire.

(1.) The rigidity of an equiaxed tungsten wire is greater than that of a freshly drawn wire, both measurements being made at the same temperature.

(2.) Heat treatment in the grain growth region causes an increase of rigidity at temperatures between 300° and 2000°K , and probably at all temperatures. Increase in the grain size causes an increase in the rigidity modulus.

Moduli of rigidity, as given in tables of physical constants, have, in general, been obtained from angles of twist which were not great enough to cause the elastic limit of the material to be passed. In the writer's research, the angles of twist were less than 0.01 degree per centimeter length of wire, and yet, at the higher temperatures, this was considerably beyond the elastic limit. The readings of the angles of twist were made so quickly that the results calculated from them were very similar to those which would have been obtained if a torsion pendulum of very short period had been used. It is suggested that the moduli of rigidity calculated from such observations be called moduli of "Instantaneous Rigidity."

*The Metallography of Tungsten, Trans. Am. Inst. Mining Eng. pp. 1037-1092, 1918.