

Dr. Tonks to condemn it. I admit an unjustified assumption in my own earlier derivation of the Lorentz formula for this case; but the remedy for it is not another equally unjustified assumption, but a more careful and critical study of the problem.

D. R. HARTREE.

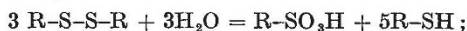
Department of Mathematics,  
Victoria University of Manchester.  
Nov. 10.

<sup>1</sup> L. Tonks, *NATURE*, **132**, 101, July 15, and 710, Nov. 4, 1933.

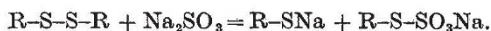
<sup>2</sup> D. R. Hartree, *Proc. Camb. Phil. Soc.*, **25**, 97; 1929: **27**, 143; 1931.

### Reactivity of the Sulphur Linkage in Wool

ASTBURY and Woods<sup>1</sup> have suggested that the action of steam in imparting a permanent set to strained fibres takes place in two stages—a primary breakdown of linkages between the long peptide chains, followed by the rebuilding of new linkages. Breakdown of side linkages is recognised from the fact that fibres steamed for 2 minutes at 50 per cent extension are then able to contract in steam to a length one-third less than the original. Supercontraction of this type may be produced in several ways<sup>2</sup>, but all methods appear to involve the sulphur linkage in wool. For example, fibres immersed in 0.0325 *N* sodium sulphide solution contract 6 per cent in about 60 minutes<sup>2</sup>, in spite of the pronounced increase in length which is the ultimate result of attack by sodium sulphide. Secondly, silver sulphate solution is known<sup>3</sup> to react with cystine according to the equation:

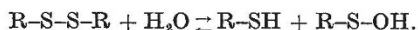


fibres boiled with saturated silver sulphate solution contract 28 per cent in 5 hours. In addition, sodium sulphite reacts with cystine as follows<sup>4</sup>:



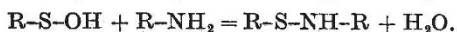
Similarly, fibres boiled with 5 per cent sodium bisulphite solution contract 24 per cent in 30 minutes.

From these and other reactions it has become apparent that the phenomenon of supercontraction is associated with the breakdown of disulphide linkages in wool, so that when strained fibres are exposed to the action of steam, the first reaction which occurs<sup>5</sup> is as follows:



That such a reaction is possible receives support from the observation, made in conjunction with C. A. Cooper, that wool heated with water in presence of mercury vapour, is rapidly contaminated with mercuric sulphide at a temperature as low as 55° C.

As regards the chemical mechanism of the rebuilding of new linkages, I have already shown that the free amino groups of lysine and arginine play a fundamental part in the reaction<sup>6</sup>. It is now evident that the amino groups must react with the products of the reaction between disulphide groups and water. Although salt formation between sulphydryl and amino groups is possible, this does not appear to be the mechanism of permanent set because although contraction of set fibres is always possible in caustic soda solution<sup>2</sup>, contraction is not accompanied by the reversion of  $\beta$ - to  $\alpha$ -keratin. In consequence, it seems reasonable to assume that the rebuilding of new linkages takes place according to the equation:



Support for this view is afforded by the fact that when fibres are treated with saturated silver sulphate solution for 17 hours in the cold, to convert the disulphide group to R-SO<sub>3</sub>H, their ability to assume a permanent set is considerably reduced, as shown by the following data. The latter express the rates of contraction in steam of treated and untreated fibres, which had been steamed for 30 minutes at 40 per cent extension.

Time (Minutes)	Percentage Extension	
	Untreated	Treated
0	40.2	39.9
2	24.4	6.3
15	13.8	1.1
30	10.4	-0.5
60	8.0	-3.7

Reactions such as the preceding, besides serving to reveal the chemical mechanism of permanent set, emphasise the reactivity of the sulphur linkage in wool. Of particular interest in this connexion is the reaction with barium hydroxide. Prolonged treatment with baryta water is known to remove the sulphur from wool, but it now appears that so deep-seated a change is preceded by the formation of an addition compound. Its formation is responsible for the inability of fibres treated with saturated baryta water for only 1½ hours in the cold to contract when boiled for 1 hour with 5 per cent sodium bisulphite solution. In addition, such fibres possess no power of assuming a permanent set.

The industrial significance of these and other reactions of the sulphur linkage in wool will receive discussion in another place.

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Nov. 18.

<sup>1</sup> Astbury and Woods, *Phil. Trans.* (in the press). H. J. Woods, *NATURE*, **132**, 709, Nov. 24, 1933.

<sup>2</sup> Speakman, *NATURE*, **124**, 948, Dec. 21, 1929. *J. Soc. Chem. Ind.* **50**, 1 T, 1931.

<sup>3</sup> Vickery and Leavenworth, *J. Biol. Chem.*, **86**, 129; 1930.

<sup>4</sup> Clarke, *J. Biol. Chem.*, **97**, 235; 1932.

<sup>5</sup> Cf. Marriott, *J. Soc. Leather Trades' Chemists*, **12**, 347; 1928.

<sup>6</sup> Speakman, *J. Soc. Leather Trades' Chemists*, 1933. Conference on the Swelling of Proteins, *J. Soc. Dyers and Colourists*, **49**, 180; 1933.

### Constitution of Neodymium, Samarium, Europium, Gadolinium and Terbium

AFTER a long and troublesome series of investigations, I have obtained settings of the apparatus for accelerated anode rays good enough to admit of a provisional analysis of the rare earth elements. Since the beams of rays are still very faint, these results could only be obtained by increasing the aperture of the slits to the limit allowing resolution. In consequence, only the roughest estimates of relative abundance can be made when the mass numbers differ by unity.

Three isotopes, 142, 144, 146, of neodymium (60) had already been identified by the first mass-spectrograph. These are now found to be definitely in descending order of abundance and 143 and 145 also shown to be present.

Samarium (62) gives a strong pair 152, 154 and a triplet 147, 148, 149.

Europium (63), as expected from its chemical atomic weight (152.0), contains the two odd mass numbers 151, 153 in roughly equal abundance.

Gadolinium (64) appears to consist of 155, 156,