

## On the Stretching and Breaking of Sodium and Potassium

This content has been downloaded from IOPscience. Please scroll down to see the full text.

1912 Proc. Phys. Soc. London 25 235

(<http://iopscience.iop.org/1478-7814/25/1/325>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 131.91.169.193

This content was downloaded on 01/10/2015 at 05:13

Please note that [terms and conditions apply](#).

XXV. *On the Stretching and Breaking of Sodium and Potassium.* By BEVAN B. BAKER, B.Sc., *University College, London.*

RECEIVED APRIL 1, 1913. READ MARCH 14, 1913.

THE nature of the structure of solid bodies, and in particular of metals, is a subject which, in spite of its importance, is rather obscure and difficult to determine. The present investigation will, it is hoped, throw a little light on some aspects of this elusive question.

*Preliminary Investigation.*—Some metals, when in the form of wires, on being stretched break off suddenly at one point, whereas others, plastic metals, thin down and finally collapse to a point at the place where they break.

Some months ago I had occasion to experiment on the behaviour of wires of metallic sodium when in a state of tension. The wires were formed by squeezing the metal through a round hole of about 2 mm. diameter into a bath of pure paraffin oil, to preserve the wire from oxidation. The wire, so prepared, was found not to collapse to a point nor to break off suddenly on stretching, but to collapse from two opposite sides only, into a chisel end.

To test whether this effect was due at all to the method by which the wires were constructed it was decided to form the wires by melting the sodium and allowing it to solidify in a glass tube.

*Method of Forming the Wire.*—A glass tube, whose internal diameter was that of the wire required, was sealed on to a much wider tube at one end, and at the other was connected by rubber tubing with an ordinary glass tap (*see* Fig. 1). The tube so formed was filled almost entirely with pure paraffin oil, which had been carefully dried, and the tap was closed. Lumps of metallic sodium were scraped free from oxide under oil and were introduced into the wider part of the tube. The tube was then placed inside a cylindrical electric furnace arranged in a vertical position, so that almost all of the narrow tubing and about half of the wider tubing was inside the furnace. The furnace was heated to about 180°C. and was kept at that temperature for a short time. The tap was then opened slightly to allow the oil to run slowly

out of the tube ; at the same time the now molten sodium ran down into the narrow tube. When sufficient oil had run out the tap was closed and the whole apparatus was allowed to cool. When cold the tube was removed from the furnace and the tap and rubber tubing were taken off. By introducing a rod, which just fitted the inside of the narrow glass tubing, the mass of solid sodium was easily pushed out into a large bath of paraffin oil.

In this way it was found possible, in a simple manner, to

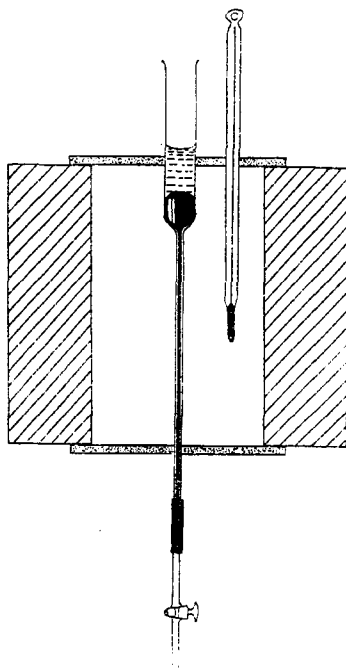


FIG. 1.

form wires of considerable length and having a remarkably smooth surface.

*Description of the Phenomenon.*—When the wire prepared in this way was stretched, it was found not to break off almost directly in one place, as the wire made by squeezing had done, but to thin, for some time, quite uniformly all along its length. This thinning was not, however, a collapse from all sides, but exhibited the same phenomenon of collapsing only from two opposite sides that the other wire had shown. For

further extension the wire gave way in certain places and broke in the chisel form.

Moreover, for wires prepared in this way a still further phenomenon became apparent which was scarcely observable for wires made by squeezing. As the wire was extended there began to be apparent on the surface markings in the form of two sets of equidistant rings encircling the wire, crossing one another and lying in planes sloped at an angle of about 45 deg. to the axis of the wire. Members of the two sets touched along the line of greatest thinning, and bisected each other along the line where no thinning took place (*see plate 1*). As the wire was still further stretched up to the breaking point the rings remained unchanged in position or slope, the only difference being that they became more clearly marked. It is noteworthy that usually one set of rings was much more distinct than the other. Microscopic examination made it clear that the rings were actual ridges on the surface.

Some experiments were also made in exactly the same way with metallic potassium, and it was found to contract and form rings precisely like sodium; there was no apparent difference in their behaviour.

Dr. Andrade had independently noticed that wires of solid mercury when stretched contract to a chisel point. On observing the rings formed on sodium wires he searched for similar rings on mercury, and found that they were formed, only that they were very much finer and closer together than in the case of sodium and potassium.

*Explanation of the Effect.*—The phenomenon thus appears to show an asymmetric structure for the metals sodium, potassium and mercury. They appear to exhibit the behaviour of plastic metals in one direction and of brittle metals in the direction at right angles.

The effect suggests that the effective portions of the metal may be in the form of cubes set so that two opposite edges are horizontal and in the same vertical plane. When vertical extension of the wire takes place, and there arises a corresponding tendency for lateral contraction, it is clear that the faces inclined at 45 deg. may slip over the similar faces of adjacent crystals, and thus allow of a rearrangement in a narrower space; on the other hand, the vertical faces can only slip over similar vertical faces, and clearly no contraction in the direction at right angles to such faces can take place.

It is clear that the crystals would pack as closely together

as possible, and would form in layers which would lie so as to make with the axis of the wire an angle of 45 deg. The rings observed on the wire would then be due to the edges of the crystals protruding at the surface of the wire

### *Description of Plate.*

(a) Wire of sodium of 3 mm. diameter drawn out to breaking. View of specimen in the plane in which no contraction takes place.

(b) Same specimen as (a). View of specimen in the plane in which maximum contraction takes place.

### ABSTRACT.

The author described how wires made of metallic sodium and potassium collapse when stretched, not to a point, as is the case with most plastic substances, but from two opposite sides only, into a chisel end.

The wires upon which experiments were conducted were made in two ways—firstly, by pressing the metal through a small hole into a bath of paraffin oil to hinder oxidation; and, secondly, by running the metal, molten under oil, into a glass tube and allowing it to solidify. Wires made by both the above methods showed the same behaviour on stretching.

Wires made by the second process also showed, on extension, two sets of equidistant rings on their surface, each inclined at an angle of 45 deg. to the axis, the rings of opposite sets touching along the line of greatest thinning and bisecting one another along the line at which no thinning takes place.

Dr. Andrade has also noticed the same effects of breaking and forming rings with wires made of solid mercury.

The author suggested an explanation of the phenomenon, based on the assumption that the portions of the metal brought into play are in the form of cubes. Such cubes when placed so that a plane through two opposite edges was parallel to the axis of the wire would allow of lateral contraction by faces sliding over one another in one direction only and not in the direction at right angles.

### DISCUSSION.

Dr. L. N. G. FILON asked if the section of the stretched wire was accurately elliptical. It was interesting to note that the angle of the rings did not change when the wire was drawn out.

Prof. A. W. PORTER remarked that it looked as if the metal possessed a lattice-like structure.

The AUTHOR stated that he had not measured the sections to see if they were accurately elliptical.

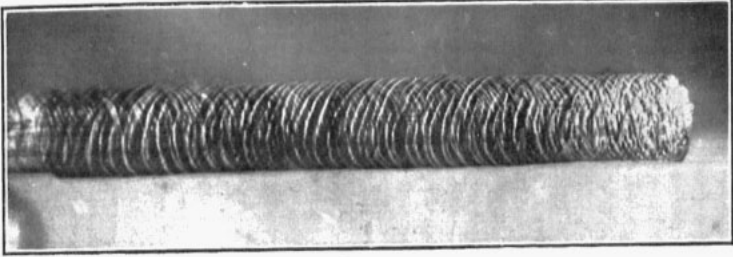


FIG. (a).

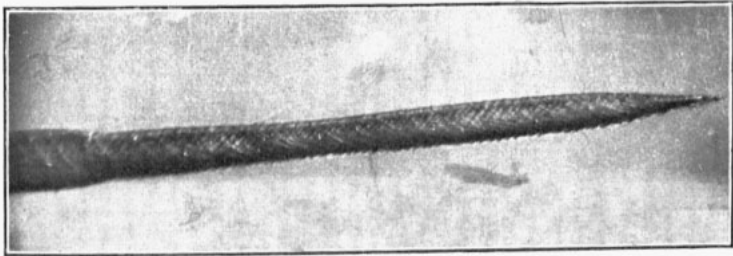


FIG. (b).

*To face p. 238.]*