Group study - stapler anvil

UNIVERSITY OF SURREY

Considering a stapler, how are the material choices linked to the mechanical requirements ?

Preparation and experiments:

The anvil of a stapler is a plate which has to resist to numerous impacts from the staples. As a consequence the mechanical behaviour of this striking plate is a key point. Also, because staplers are widely used in everyday life and because there are a lot of competitors on the market, cost reductions are important. As a consequence, the aim of this study is to analyze how it is possible to respond to these criterias by choosing the right material for this striking plate.

The first thing that has been done for this study is to extract the anvil from the original stapler.

Figure 1: the striking plate

After the extraction, the anvil has been prepared in order to run some tests on it. A small sample was cut, polished and then the specimen went through three different tests to determine the mechanical properties and the characteristics of the striking plate.

The first one of them was the hardness test. It measures a plastic deformation, or more precisely the size of the indentation left in the material by a diamond shape. The size of the indention is then easily converted in Vickers hardness via a table. The mechanism can be seen figure 2.

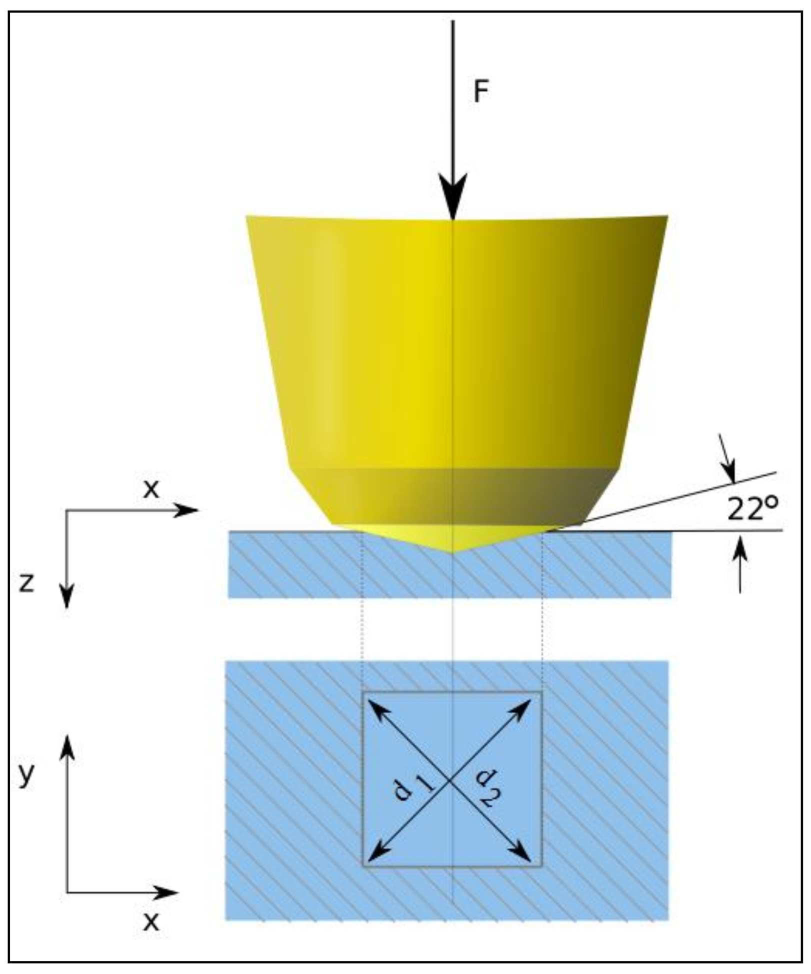

Figure 2: the hardness test

The other two tests were optical microscopy and scanning electron microscopy. The aim was to be able to determine the microstructure and the composition of the specimen in order to link the results to the basic mechanical properties of the striking plate.

Figure 3: Optical microscopy (left) and scanning electron microscopy (right)

Results and discussion:

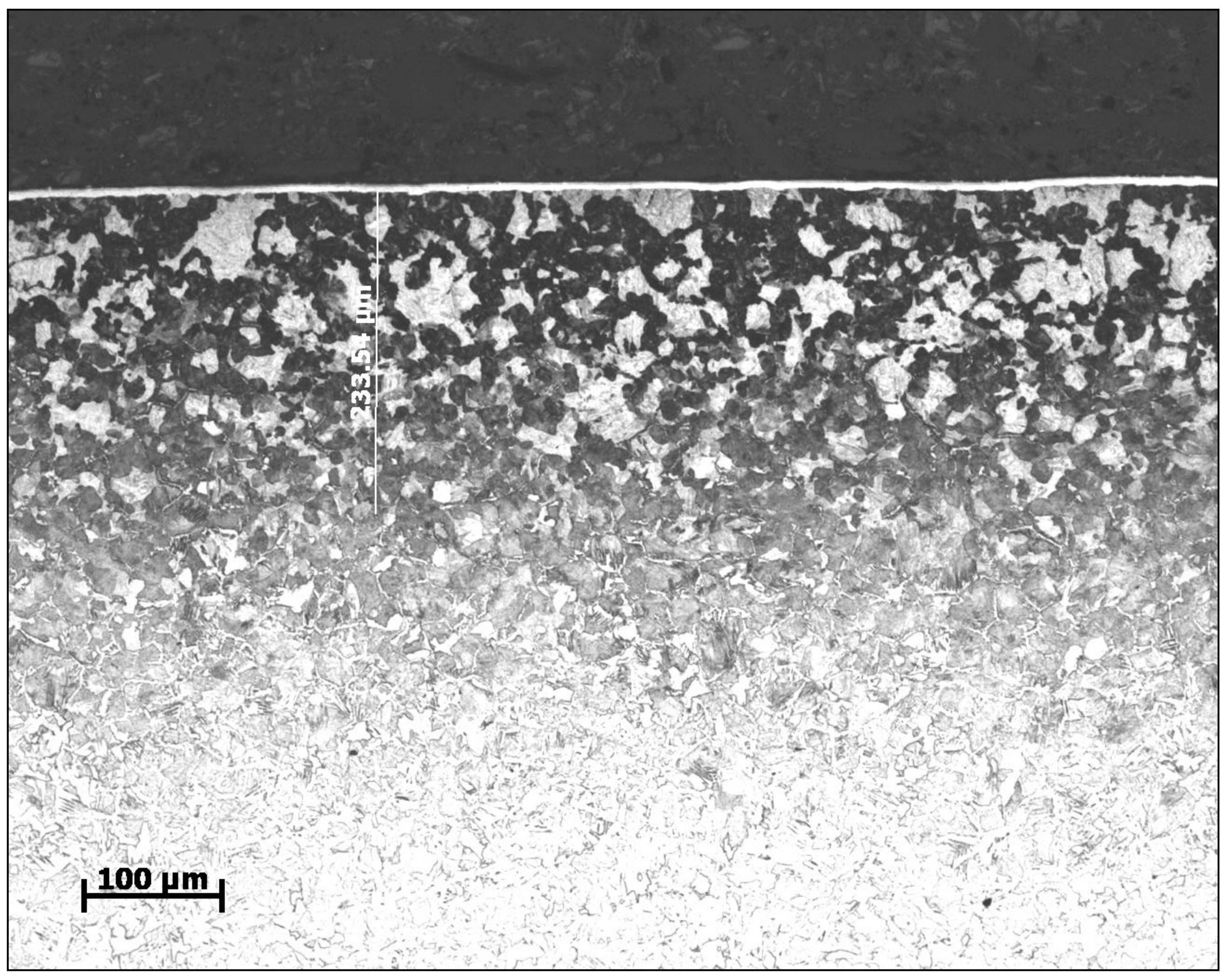

Figure 4: Microstructure of the striking plate.

The figure 4 is a capture from the optical microscopy.
Several things can be pointed out:

- A martensite microstructure at the edges of the plate
- A ferrite microstructure in the bulk of the specimen
- A nickel coating (decorative)

Furthermore the SEM experiment gave some interesting results. Indeed it showed the following composition for the specimen:

- 6 C %wt, 94 Fe %wt near the surface
- 2.2 C %wt, 97.8 Fe %wt in the bulk of the striking plate

Even if these %wt are not very accurate due to experimental issues (including contamination from backelite used to prepare the specimen and some background noise), it is important to understand that there was probably more carbon near the surface of the plate.

This leads to two important conclusions. First, the microstructure appears to be linked to the depth of the specimen. As a consequence a surface heat treatment has been made and has affected the microstructure. Second, the concentration of carbon seems to be also different depending on the depth where the measurement was done. Therefore, the striking plate probably went through a carburizing treatment while manufactured.

Figure 4 shows the schematic result of such treatments on the hardness of the anvil.
The Vickers hardness increases as the measurement is done closer to the surface of the material. However the hardness deeper in the bulk remains the same and is close to a standard steel (135HV).
This has many advantages. Indeed, mechanical properties at the surface are satisfied (impact resistance) even if cheap steel is used in the bulk. Also, a brittle behaviour of the anvil after impacts is avoided.

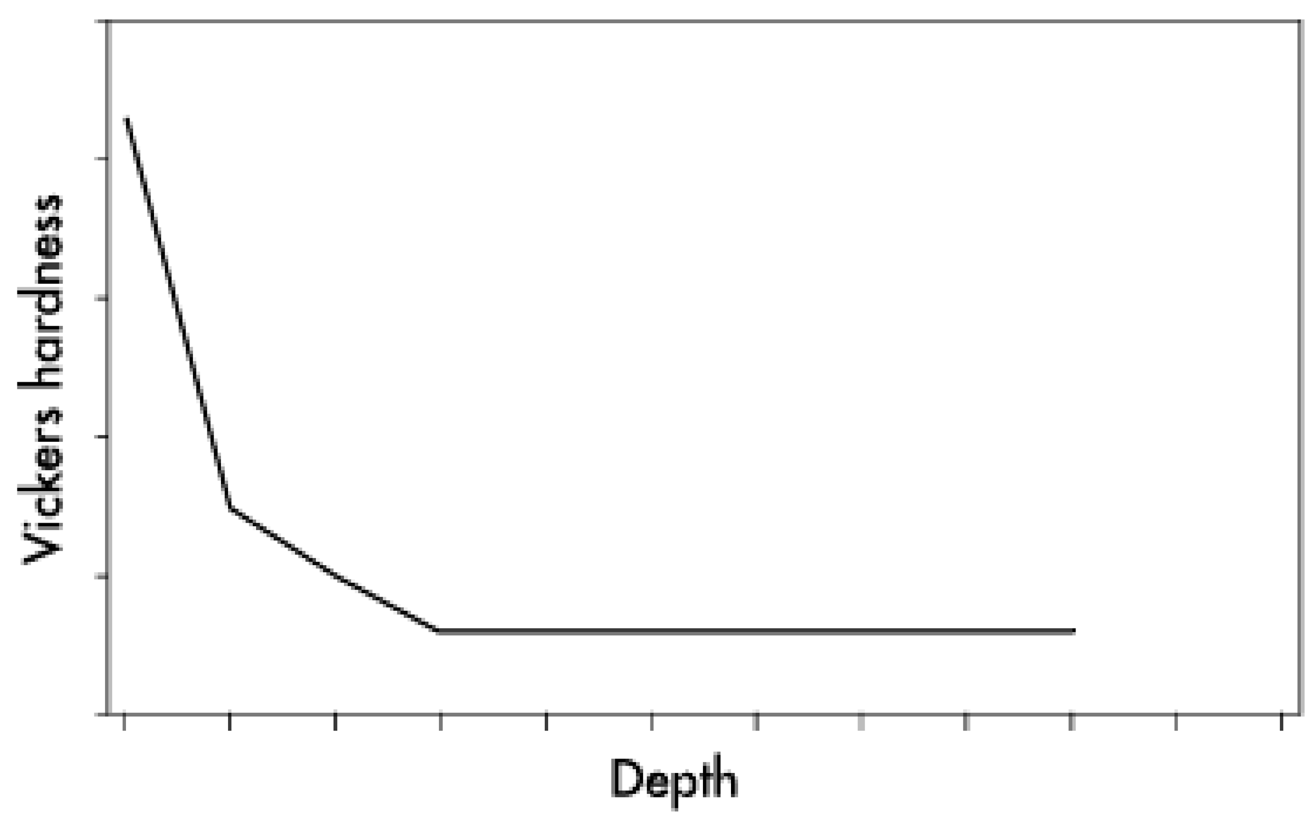

Figure 4: Microstructure of the striking plate.

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