Hydrogen Charging and Characterization of bulk Steel Samples

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Hydrogen can be used as fuel for a zero-emission economy [1, 2]. However, there are some risks and limitations, such as hydrogen embrittlement (HE), leading possibly to failure of hydrogen containing metal vessels and subsequent unintentional release of hydrogen – a non-negligible safety issue [3, 4].

These effects are intrinsically linked to hydrogens various interactions with the materials microstructure (fig. 1) [5]. Understanding those interactions on an atomic scale is crucial for overcoming the aforementioned safety issues to pave the way for a safe and efficient hydrogen economy.

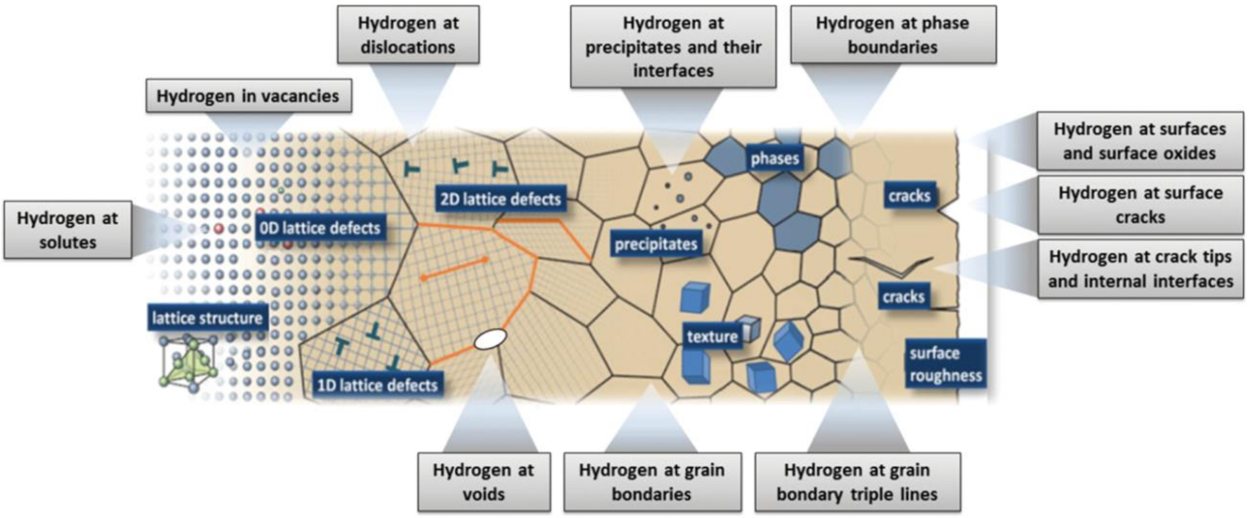

Fig. 1. Schematic showing the various interactions of hydrogen with a materials microstructure. To understand the interplay and to identify the governing mechanisms of hydrogen embrittlement it is crucial to unravel the kinetics of the different processes by mapping hydrogen with microstructural precision, taken from [5].

However, to detect and monitor hydron on an atomic scale is a challenging task and only a few techniques are capable to reach that precision. Among them atom probe tomography (APT) is regarded as the one with the highest spatial resolution, being able “to resolve nanohydrides and positions of single hydrogen atoms e.g. at specific traps" as reviewed by Koyama *et al*. [5].

A Phd student at our institute, Jonas Arlt, is working on hydrogen detection by APT within steel samples containing a chosen microstructure of interest. Those samples need to be charged from the gaseous phase with hydrogen before the APT experiment within a separate loading chamber.

The task of the bachelor student would be to use the existing loading chamber to load pristine bulk steel samples as well as samples covered with a thin (< 15 nm) catalytic surface layer with hydrogen and to characterize the amount of charging by thermal desorption spectroscopy (TDS) under different loading conditions (e.g. temperature, gas pressure).
Besides the coating technique (electron beam induced thermal evaporation and subsequent deposition) and TDS the student would get insights in transmission electron microscopy (TEM) and APT whilst working in strong collaboration with the Phd student and technical staff of the IMP.

References

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