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Paper presentation

Observation of hydrogen trapping at dislocations, grain boundaries, and precipitates

Yi-Sheng Chen[1,2], Hongzhou Lu[3*], Jiangtao Liang[4], Alexander Rosenthal[5], Hongwei Liu[6], Glenn Sneddon[1,2], Ingrid McCarroll[1], Zhengzhi Zhao[4], Wei Li[7], Aimin Guo[3], Julie M. Cairney[1,2,*]

[1]*Australian Centre for Microscopy and Microanalysis, The University of Sydney, Sydney, Australia.*
[2]*School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney, Sydney, Australia.*
[3]*CITIC Metal Co., Beijing, China.*
[4]*Collaborative Innovation Center of Steel Technology, University of Science and Technology Beijing, Beijing, China.*
[5]*Microscopy Solutions Pty., Caulfield North, Australia.*
[6]*Sydney Microscopy and Microanalysis, The University of Sydney, Sydney, Australia.*
[7]*Institute of Advanced Steels and Materials, School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai, China.*

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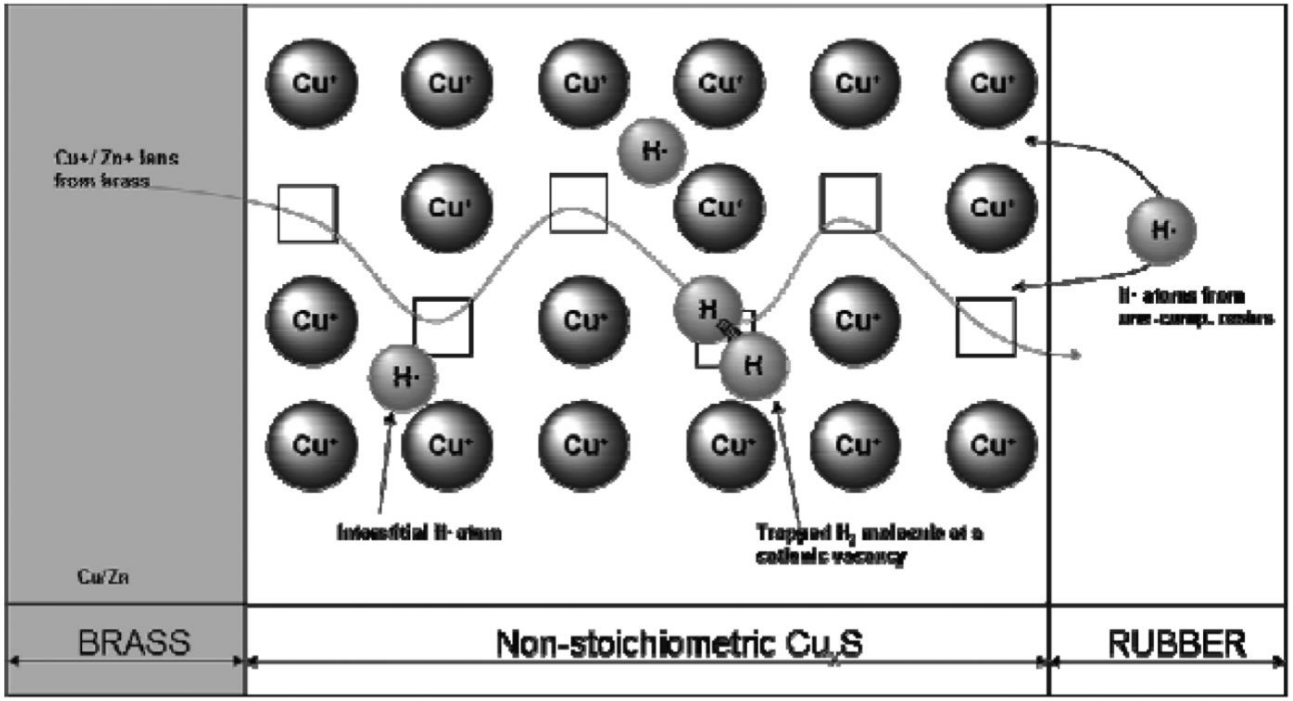
Terminologies

- Hydrogen embrittlement: Hydrogen embrittlement is a metal’s loss of ductility and reduction of load bearing capacity due to the absorption of hydrogen atoms or molecules by a metal.

- Dislocation: Its a linear crystallographic defect or irregularity within a crystal structure which contains an abrupt change in the arrangement of atoms.

Significance of the paper to the group



A schematic of ionic diffusion pathways and their blockage by hydrogen molecules. The diffusion pathways are formed through cationic vacancies in non-stoichiometric Cu_xS (sulfur atoms not shown for clarity).

William J. Vanooij, Prasan B. Harakuni, Guy Buytaert; Adhesion of Steel Tire Cord to Rubber. *Rubber Chem. Technol.* **2009,** 82 (3): 315–339

Background work

Contents lists available at ScienceDirect

Engineering Fracture Mechanics

journal homepage: www.elsevier.com/locate/engfracmech

Hydrogen assisted intergranular cracking in steels

H.W. Liu *

Dept. of Mech. & Aerospace Engineering, 223 Link Hall, Syracuse Univ., Syracuse, NY 13244, USA

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Engineering Fracture Mechanics 68 (2001) 671–692

Engineering Fracture Mechanics

www.elsevier.com/locate/engfracmech

The effect of hydrogen on dislocation dynamics ☆,☆☆

I.M. Robertson *

Department of Materials Science and Engineering, University of Illinois, 1304 W. Green St, Urbana, IL 61801, USA

Introduction

- Automotive industry, which is looking to use high strength steels to increase fuel efficiency by reducing weight while still meeting strength requirements. Steel is also used for the hydrogen-pressurized pipes and storage containers that would be required to underpin hydrogen fuel as a form of energy.

- The specific origin of hydrogen embrittlement has long been a topic of debate, and no precise proposed mechanism exists that is consistent with all the observed HE consequences.

- Experimental difficulties to identify the location of hydrogen: the combination of the low level of interaction between an electron and hydrogen and the extremely fast diffusion of hydrogen in steels renders it extremely difficult to experimentally determine its location.

- In this paper, niobium-bearing low-carbon steel to two different heat treatments to produce ferritic and martensitic states.

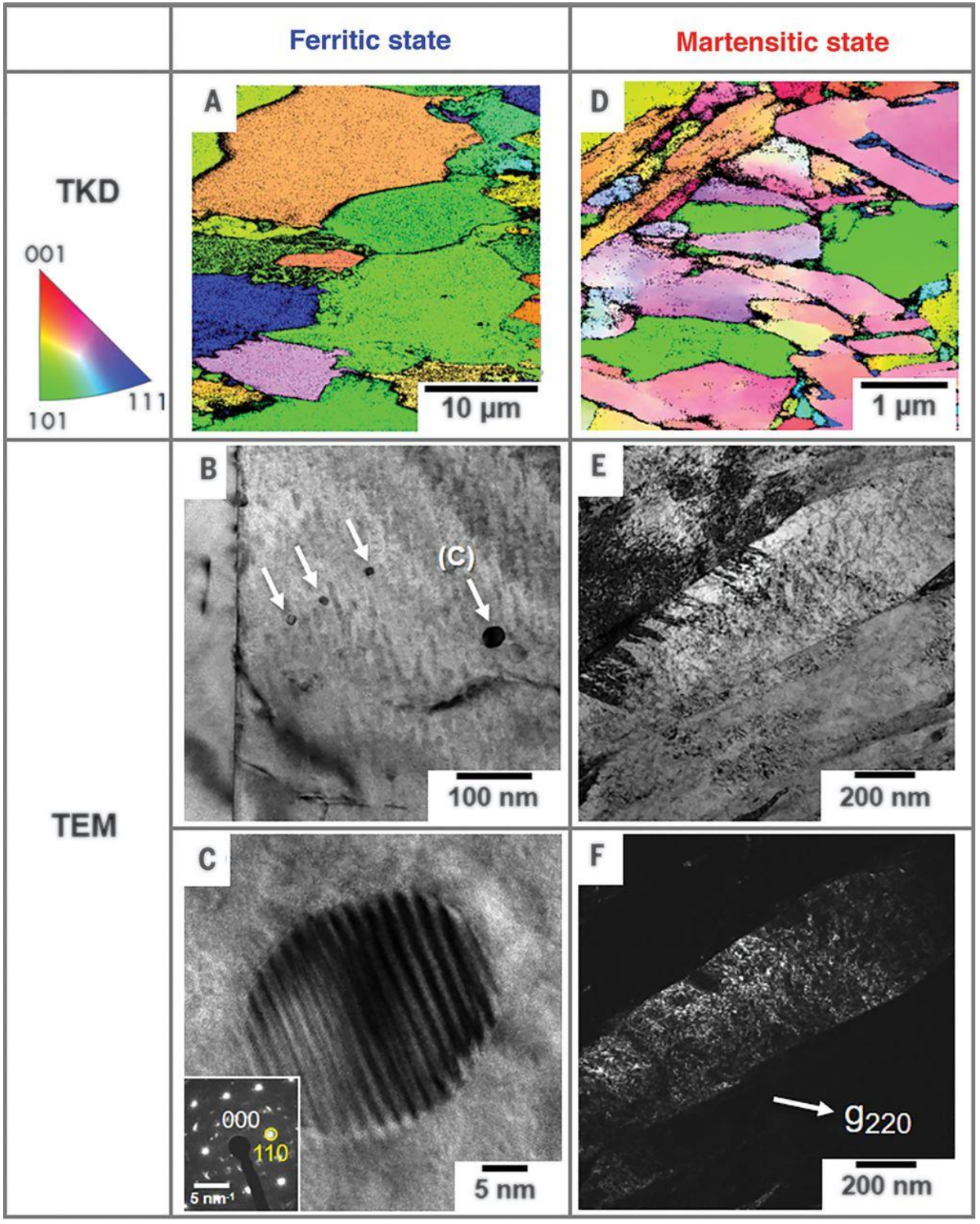


Fig. 1 Microstructure of the ferritic and martensitic steels.

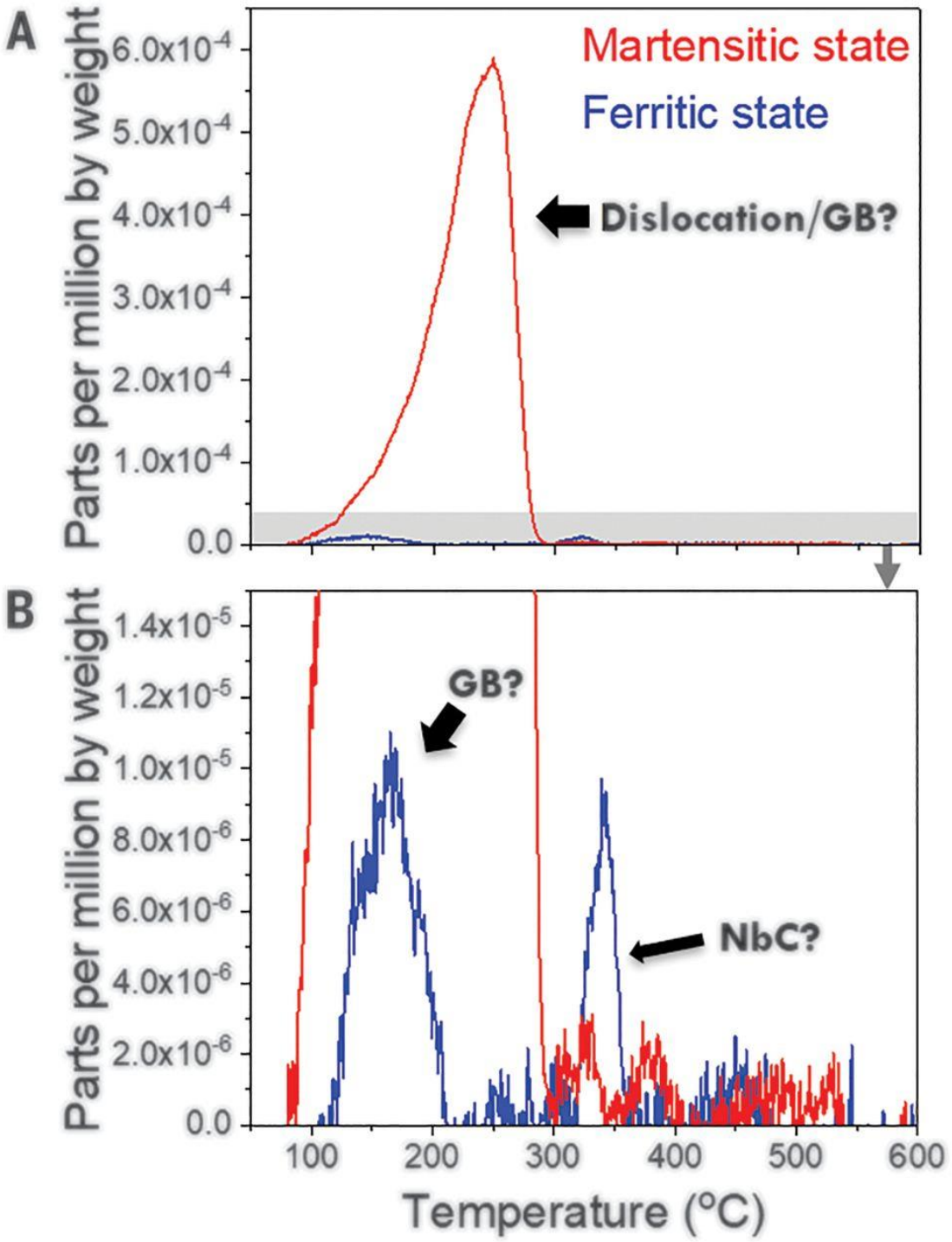
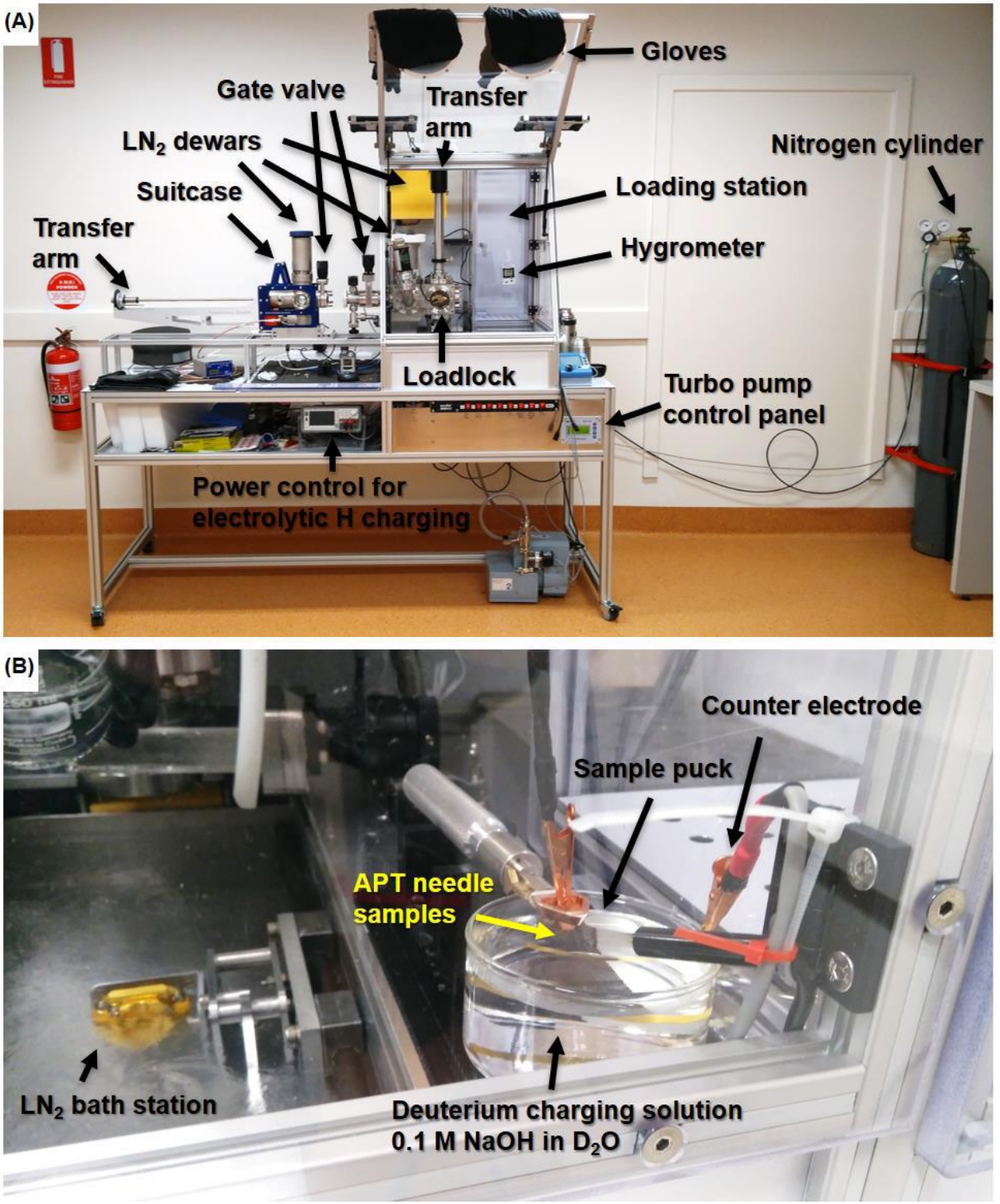


Fig. 2 TDS data showing the temperature at which trapped hydrogen is released for the two types of steel.



(A) The glove box, open, with the suitcase detached, showing the configuration of the cryo-transfer system.

(B) Deuterium charging underway showing the configuration of the charging system and the LN2 bath.

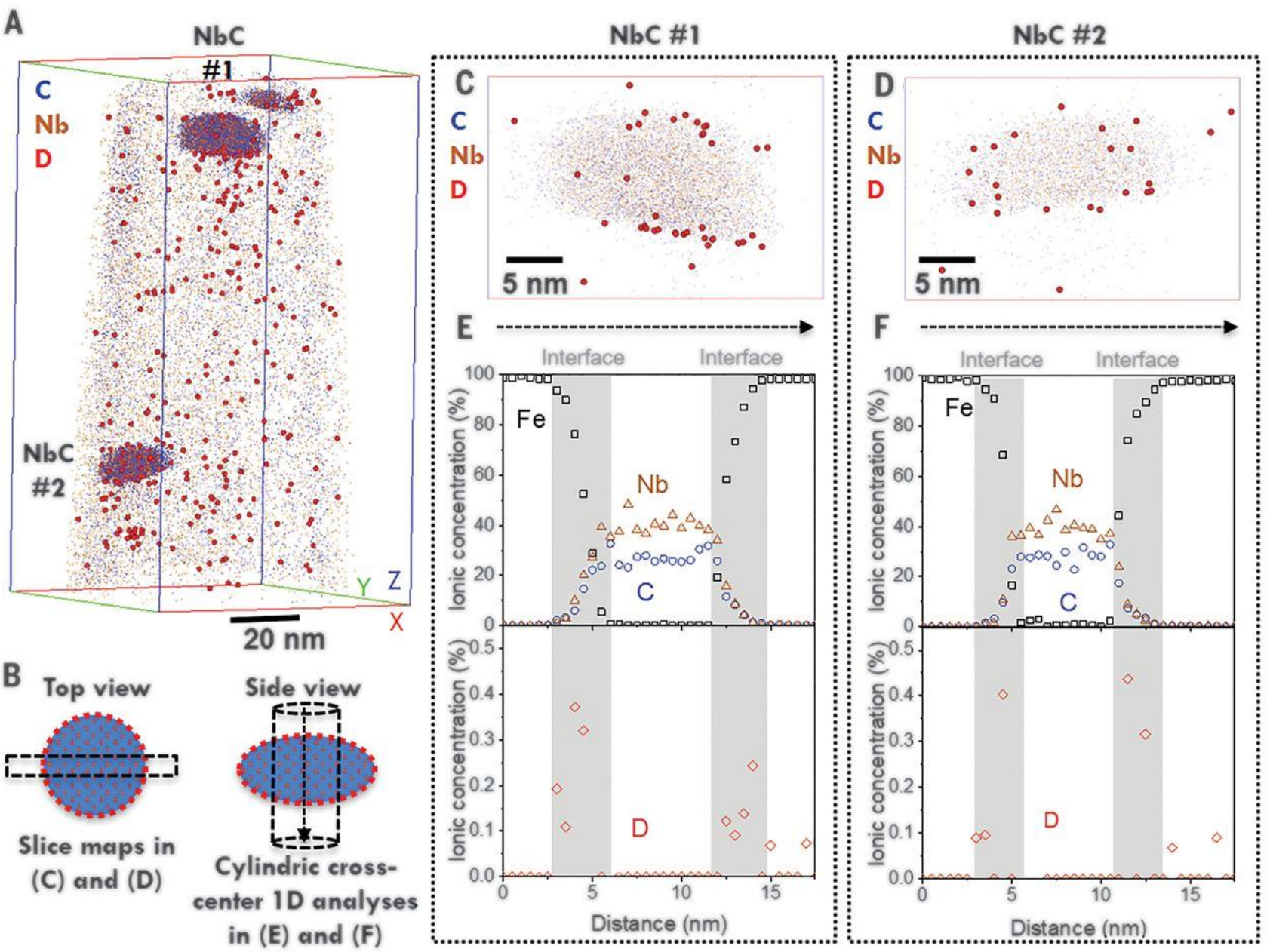


Fig. 3 APT analysis of a deuterium-charged ferritic steel sample containing NbC.

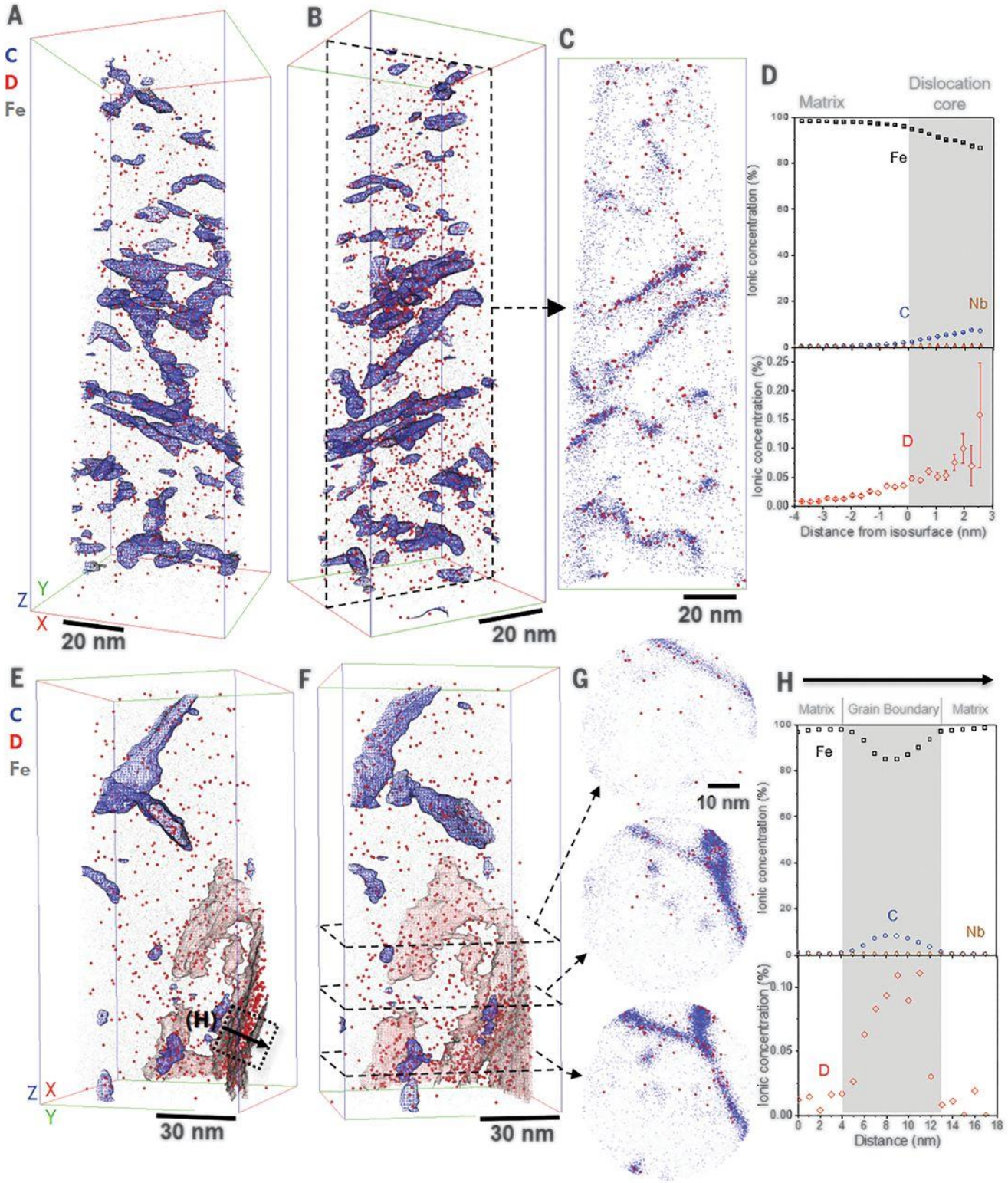
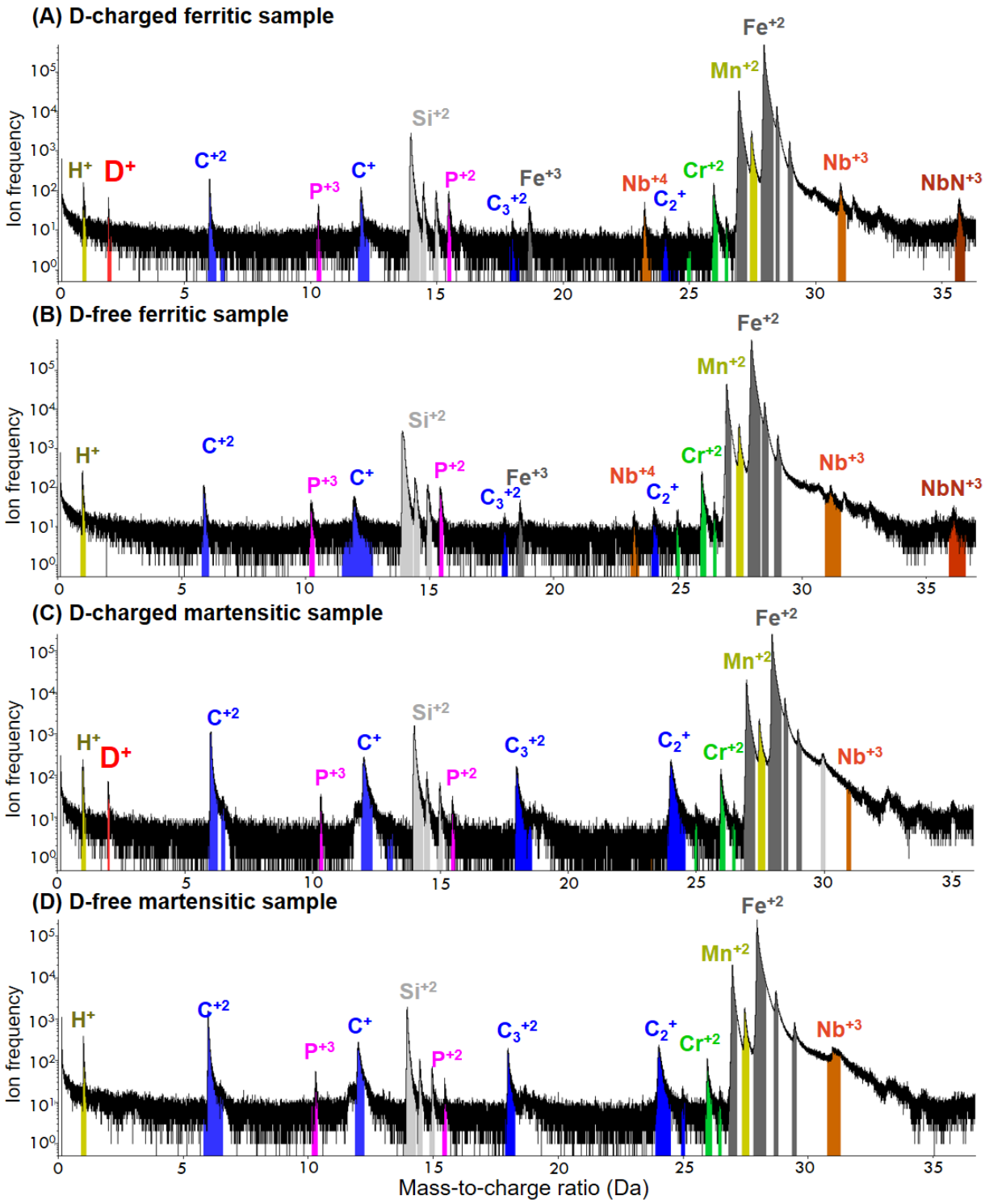


Fig. 4 APT analyses of deuterium-charged martensitic steel samples containing GBs and dislocations.



Mass spectra (log scale) with peaks and ranges labelled.

Conclusion

- Observed hydrogen is directly related to the presence of lattice defects, rather than the result of attraction by segregated carbon atoms.

- Cryogenic APT has enabled the measurement of the distribution of hydrogen at dislocations, GBs, and precipitates.

Thank you ☺