

# Enhanced production of vibrationally excited H<sub>2</sub> molecules using fast atoms

B. Crowley<sup>1</sup> M. Kovari<sup>1</sup> and A.J.T Holmes<sup>2</sup>

<sup>1</sup>EURATOM/UKAEA Fusion Association, Culham Science Centre, Abingdon, Oxfordshire, OX14 3DB, U.K.

<sup>2</sup> Marcham Scientific Ltd., Sarum House, Hungerford, Berkshire, RG17 0LH, U.K.

We propose a method for enhancing the population of hydrogen molecules in high vibrationally excited states by collisions with fast neutral atoms. We propose a negatively biased insert next to the extraction aperture, at  $\approx -20\text{V}$ . Protons are accelerated across the plasma sheath onto the surface of the insert. Some will be reflected as neutral atoms, with some of their original energy (up to 70% reflected, with  $\sim 70\%$  of original energy).

Figure 1 shows that the cross-section for excitation of H<sub>2</sub> (ground state) to H<sub>2</sub>( $v'$ ) by H atoms, summed over final vibrational levels  $v'=5$  to 14, is substantial over a wide energy range. The hypothesis that vibrationally excited molecules are the precursor of H<sup>-</sup> ions in volume sources is confirmed by agreement between predicted and measured H<sup>-</sup> densities[1]. By accessing this “fast neutral” excitation channel it would be possible to use a lower electron temperature in the driver, thus reducing the destruction of H<sup>-</sup> by fast electrons leaking through the filter. The excited molecules are created close to the aperture where they are needed. The paper presents a model as to the likely impact that the mechanism has on negative ion production.

Many negative ion sources use a positively-biased insert in conjunction with a magnetic field for the purpose of electron suppression. This would still be possible, by using a positive insert in the extraction aperture itself, and a negative insert next to it, on the plasma side. Others have suggested using protons to create excited molecules [2], but we believe the use of fast neutrals has not been described before. A negative ion extraction experiment using a twin insert of this type is being prepared at the JET Neutral Beam TestBed.

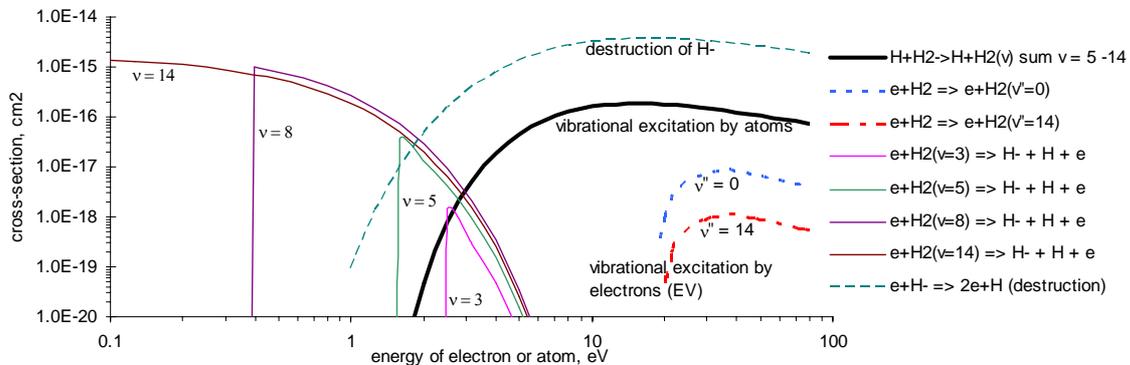


Figure 1. Cross-sections for vibrational excitation by atoms (Fast Neutral), and by electrons (E-V process); creation of H<sup>-</sup> by AD process; and destruction of H<sup>-</sup> by electrons.

## References

- [1] M. Bacal, Review of Scientific Instruments **79**,02A516 (2008)  
 [2] R. Becker, 11th Int'l Symposium on the Production and Neutralization of Negative Ions and Beams, AIP Conference Proceedings No. 925, p. 145 (2007)

**Acknowledgement:** This work was funded jointly by the United Kingdom Engineering and Physical Sciences Research Council and by EURATOM under the contract of association between EURATOM and UKAEA. The work was carried out within the framework of the European Fusion Development Agreement. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

**Topic:** 1. Fundamental processes and modeling

**Corresponding Author:** Brendan Crowley

brendan.crowley@jet.uk

Euratom/UKAEA Fusion Association, Abingdon OX14 3DB, UK

+44 (0)1235-46-4539, +44 (0)1235-46-4838