

Past AVT Panel Lessons Learnt

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ABSTRACT

The paper gives a brief review on the outcome of past AVT panels, in particular, with respect to AVT136, task group “Gas-surface-interaction”. With the performed assessment in AVT136 first activities were identified needed to assess an increased confidence in catalysis relevant data and, moreover, a consolidated approach to perform research and development in the field. As a consequence of the outcome, some activities were initiated, their current state is briefly outlined.

1.0 INTRODUCTION

In [1, 2] the outcome of a several months activity within “Gas surface Interaction” is summarized. Here, a review of existing experimental methods and numerical tools to assess catalysis was developed together with some preliminary thoughts on potential improvements for the measurement of recombination data per se but also for the determination via numerical tools and the potential use of data as such in tools that aim for the description of atmospheric entry spacecraft and their respective thermal protection system.

2.0 IDENTIFIED AND NEEDED ACTIVITIES TO IMPROVE ASSESSMENT OF CATALYSIS

The citations below represent the outcome of the previous RTO AVT activity as reported in [1, 2]. Moreover, further activities are described in item numbers 4 and 5.

1. “Establishment of an international catalysis working group e.g. on ESA level. This group will give an umbrella for the following activities and, in addition, informal meetings will allow the identification of potential advancements in both fields (experiment and model) and e.g. definition of reference test cases and conditions.”
2. “Correspondingly, a first research proposal could be the realization of a relational data base for experimental catalysis data- at least as long as the catalysis data (recombination coefficients and energy accommodation) have not already been established e.g. in the models by the use of measured recombination coefficients. This review can be used to link the origin of the data, the methodology i.e. how the data were measured and relevant issues such as assumptions, measurement technique used and modelling support. This will guarantee a traceability of the data and statements of their relevance on the theme of atmospheric entry. A similar assessment has to be performed with models that derive catalysis data. Of course, flight data have to be included within the combined data base. The obtained data bases have to be cross-linked in order to have a verification tool.” [3]
3. “Overall in a following step a metrological analysis of the methodologies should be performed.” Here, significant support can come from item number 2. This also includes e.g. round robin tests, assessment of systematic differences in the different determination methods (relational data base)

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and mathematical approaches to assess the interdependencies within the used methods [3].

4. Validation effort for models and the respective codes: round robin tests, code to code comparison, code validation on basis of experimental data. The latter is considered as a major issue and will be addresses within an upcoming PhD project. The intention is to develop a highly optimized one-dimensional DSMC (Direct simulation Monte Carlo, for basic principles see [4]) code with the purpose to *calibrate* catalysis relevant data on basis of experimental measurements. Those measurements contain information which are currently not covered by standard catalysis models, like surface roughness [5], and the typically unknown surface heating which is simplified by assuming a (constant) surface temperature in advance. Both surface roughness and the surface temperature are relevant for the derivation of macroscopic rate coefficients produced by KMC (Kinetic Monte Carlo [5]) codes which need microscopic rate coefficients as input.
5. Another recommendation made in [1, 2] was about the development of wide scale numerical methods in order to close the chain of derivation and application of rate coefficients for surface chemistry. “Scale” was considered as spatial and/or temporal quantity. However, unresolved catalysis relevant phenomena exist with respect to additional types of scales. Hence, we extend the definition of “scale” to two additional meanings: mole fraction scale, and Knudsen scale. The former is currently addressed via the modelling of trace species elements in DSMC using so called varying particle weights [6]. The model is supposed to improve adsorption and recombination process resolution by orders of magnitude considering that the relaxation zone close to the surface in high enthalpy flows is usually a high Knudsen number region, i.e. DSMC domain. This is also supported by the surface roughness which increases Knudsen number additionally. Code verification activities are still ongoing, results will be presented as soon as available.

A full picture of previously given recommendations and respective activities are depicted in Fig. 1. It is basically a 3x3 matrix summarizing and structuring the information given above. The first block (at the left) shows that a catalysis working group might define test cases and standards which affect also the catalysis data base (middle block) presented in another talk. The right side of Fig. 1 represents the proposed numerical activities as well as the supposed tasks. “Old” phenomena are considered those which are covered by some model which needs improvement. This can be the implementation of a wall temperature model (multi physics) in order to add justification to the use of temperature dependent surface properties. “New” phenomena are those not covered so far like the resolution of trace species like NO which is a strong radiator, thus (potentially) increasing radiation heat load to the wall which then affects the wall temperature.

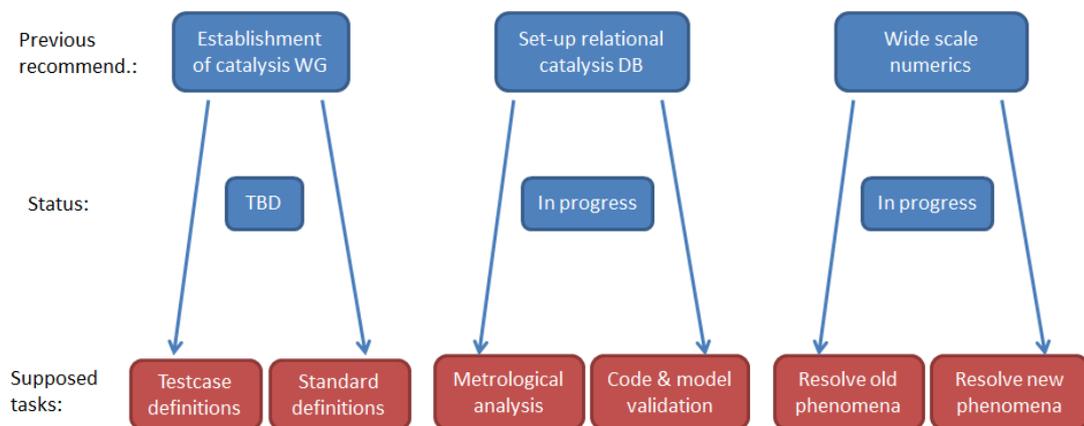


Figure 1: Recommendations, state of development, and supposed tasks

3.0 REFERENCES

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