

IS NOW THE TIME FOR A GLOBAL TERMINOLOGY IN FRACTURE MECHANICS ?

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As the quite recent change of the name of EGF into ESIS has underlined, there is always a need to reevaluate terms. In this presentation the issues behind terminology work, the subject areas in close relation with fracture testing and the present activities on behalf of ASTM, IUPAC and ESIS (formerly EGF) are discussed. Goals for future work, including a multi-lingual catalogue, are indicated.

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INTRODUCTION

Ever since people have formed societies, by having invented and used language and the art of writing, they have given rules to these human tools. As it seemed, not always entirely sufficient ones. Already in 500 BC Confucius answered, when asked what he would be doing if he were a dictator "*Define with precision the sense of the words*". In science and technology such a need was even more evident. Universal definitions for physical units, chemical compounds and living species have been adopted for a long time (in the latter case the latin language served the purpose). Evidently with the increasing complexity of technical developments and the widespread distribution and exchange of machines and structures, but also of systems, concepts, and methods of fabrication, test and control an unambiguous description became necessary. Standard terms have progressively been used since the end of the last century. (In 1831 the Prussian pressure vessel formula still spoke of "*absolute cohesion*" when it meant *tensile strength* [1]).

The development of new materials with new properties and uses, of new methods of characterization, and the changing human environment provide the driving forces for a continued reevaluation of technical terms and - if necessary - of their change and adaptation. Guidelines for terminology work are : easy and unambiguous communication, respect for the developed language(s) and their tradition, logic and precision, and nevertheless, a certain elegance and simplicity. The specific problems to be treated in fracture arise from the wide span of subject areas that could be included in fracture terminology : continuum mechanics, testing technology, structural and design aspects, and last but not least materials science.

This presentation wishes to point to the issues, sketch present activities, and help to stimulate future ones.

THE ISSUES

The scope of most technical activities towards a standard terminology is based on the thoughts exposed in the introduction : elaborate and have adopted standard definitions, descriptions of terms, symbols, abbreviations, and - if suitable - units. The subject areas to be tightly covered by a terminology related to fracture testing, are evidently :

- ☐ the crack, its geometry, state of stress, displacement and physical environment
- ☐ the material response to a crack
- ☐ the geometry of fracture testing samples
- ☐ the loading conditions.

Some of these areas partly overlap with others :

- ☐ continuum mechanical theory of elasticity and strength
- ☐ viscoelasticity, plasticity, rheology.

Since it would be out of scope for any one committee to review all relevant terms in all of these subject areas it can only be attempted to

cover fracture testing in a narrow sense and to adopt other terms as they are used elsewhere.

An important issue in defining a term certainly is that some significance can be given to any numerical value attached to it. This generally implies reference to the methods of its experimental determination. This would be especially necessary in the case of rate sensitive and /or strain-hardening materials, notably polymers. For the latter materials care must be taken to properly define the range of validity of linear elastic fracture mechanics methods and to set up standard test conditions accordingly. In fact, this issue was the principal reason for the creation of the *EGF Task Group on Polymers and Composites* [2].

A final issue of any terminology work is language. This article is being written in English and English will be the major language of reference for a standard terminology. However, in daily practice such terms will mostly be used in (many different) national languages. It will thus be necessary to assure their proper translation which will be particularly cumbersome if apparently identical terms have a narrower or wider meaning in another language (like the French *diffusion* which has the meaning of *diffusion* and also of *scattering*).

PRESENT ACTIVITIES

ASTM Subcommittee E 24.05 on Terminology.

This committee can be credited with probably the longest standing activity in *standard terminology relating to fracture testing*. The first result of its work was the ASTM Standard E 616-77. The current edition (E 616-89) was approved in Feb. 1989. This Standard references 13 fracture related ASTM Standards mostly concerning metallic materials. It defines 52 terms and gives a description of 10 others : In each case the terms (e.g. plane-stress fracture toughness) the *symbols* (K_{IC}), its *measure* ($[FL^{-3/2}]$) its *definition* (if applicable with mathematical expression or figure), and the *document* where it is used are listed (in alphabetical order of terms). Two annexes, recommending (SI) units and *designing codes for specimen configuration, applied loading and crack or notch orientation* are attached. Use of this Standard has been made in establishing the proceedings of this conference.

IUPAC* Commission IV 1 on Macromolecular Nomenclature

Apart from its main task to continue defining the nomenclature of compounds, the commission has set up a subcommittee (chaired by W.J. Work) to deal with *basic terms relating to the bulk properties of polymers*. Besides typically material related and viscoelastic terms, there are also included mechanical properties, state of stress and fracture, e.g. crack, fracture toughness and Griffith criterion. The work of this subcommittee is still in progress.

ESIS Committee on Terminology

As pointed out by L.H. Larsson, President of ESIS, the interdisciplinary area covered by ESIS activities is so wide that it is vital for an efficient communication to agree on the definitions and apply unified terminology, symbols and units [3]. The Task Group on Polymers and Composites has already worked on these problems (see Newsletter 7, p. 8). Since this concerns in fact all Task Groups and Working Parties, it has been considered necessary to coordinate all these efforts through a new ESIS Committee on Terminology with the following draft terms of references :

- ☐ define a unified terminology and definitions
- ☐ develop standards for symbols and units
- ☐ establish interfaces with all ESIS Task Groups and Working Parties
- ☐ establish links and collaborate with other organisations world-wide.

In fact this presentation is the direct result of the intensified efforts of ESIS in this domaine.

* (Int. Union of Pure and Appl. Chemistry)

Fracture Research Multilingual Dictionary

Under the editorship of H.P. Rossmanith [4] experts from 15 countries (mostly members of ESIS) have started to compile a multilingual dictionary (not an encyclopedia) of fracture research, failure analysis and its applications in various fields of engineering ; the following scheme of organization is proposed by the editor :

No	English	French	German	Russian	
...
10	aircraft	avion	Flugzeug
11	amplitude	amplitude	Amplitude
12	application	application	Anwendung
...

The number of technical words and expressions will be about 3000 from the fields of fracture mechanics, damage mechanics, failure mechanics, materials testing and applications. The range of application will be extended to cover all areas from hydro-fracturing of rock, extraction up to ultrasonics.

English = reference language, German, French, Spanish, Portuguese, Italian, Chinese, Japanese, Arabic, Russian, Dutch, Swedish, Polish, Greek, Hungarian and possibly others.

It is believed that this multi-lingual dictionary serves for most applications. The multi-lingual dictionary should be made available also on diskettes and with wordprocessor (even for Russian, Japanese, Chinese and Arabic). Details of this ambitious and important project will be discussed at ECF8 in Torino.

OUTLOOK

Hopefully the ESIS Committee on Terminology can be formally constituted in Torino and can start its work towards the goals discussed above. Close cooperative interchange with ASTM, ISO and IUPAC externally, and internally with the ESIS Task Groups is absolutely indispensable.

In order to answer at last the question raised in the title : yes, now is the time to work towards a global terminology in fracture mechanics, toward an unambiguous, precise vocabulary serving simultaneously the fracture community in metallurgy, ceramics and polymer science, a vocabulary understood also by the non-expert and compatible with the language of physicists, chemists and rheologists.

REFERENCES

- [1] Referenced after "Werkstoffprüfung", H. Blumenauer, ed., VEB Deutscher Verlag für Grundstoffindustrie, Leipzig (1987).
- [2] See for instance the accounts of the regular Diablerets - Meetings in EGF - Newsletter, e.g. No **10**, p. 7 (1989).
- [3] Larsson L.H., *ibid* **10**, p. 7 (1989).
- [4] Rossmannith, H.P., Technical University, Inst. of Mechanics. Karlsplatz 13 - **1040 Vienna**