Brittle Fracture Group

/ Department of Mechanical Properties / Institute of Physics of Materials
/ Academy of Sciences of the Czech Republic

RESEARCH GROUP CONTACT

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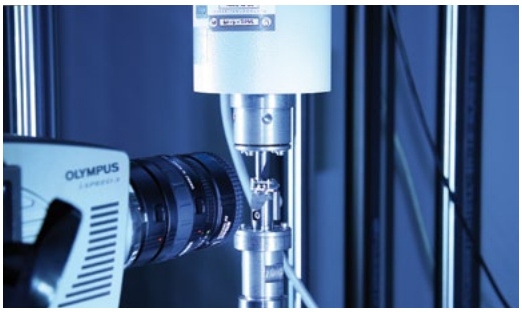

THEMATIC RESEARCH FOCUS

RESEARCH AREA

Experimental fracture mechanics and fracture of steels, ceramics, intermetallics and composites

EXCELLENCE

Wider world-top, 3 researchers (from 6) are in the best 25 % of this field in the world

MISSION

To maintain our current position in world science and progress further to be considered among the best

DEVELOPED TECHNOLOGIES

CONTENT OF RESEARCH

- Research on initiation and fracture micromechanisms in advanced metallic materials, influence of microstructure and selected production parameters
- Investigation of the principles of experimental fracture mechanics, development of new test approaches enabling better understanding of deformation and fracture of (heterogeneous, composite) materials
- Fracture behaviour of new advanced materials (ceramic matrix composites reinforced e.g. by ceramic fibres, particles, silicon carbide nanoparticles, carbon nanotubes etc.)
- Experimental research focused on and failure analyses connected with practical and/or industrial problems including participation in Euroatom materials development and evaluation activities

MAIN CAPABILITIES

The brittle fracture group is able successfully deal with / contribute to solving the material problems generated by industrial practice, but 90 % of the team activity is focused on basic research.

The following topics may be solved in collaboration with industrial partners – development centres:
Fracture behaviour/resistance of steel - the verification and modification of knowledge for transferability of laboratory data to real components. There are good results in the field of fracture resistance prediction (for steels) applicable for commercial use which we can complete in the case of a real offer and/or support from industry.

Based on fracture toughness evaluation of about 10 different types of ceramic matrix composites, further investigation in this field including possible application of knowledge is possible. Assistance in evaluation/ quantification of ceramics and ceramic matrix composites degradation is also possible.

The knowledge obtained with TiAl intermetallics enables effective assistance in the further development of these materials; recently an attempt was made to modify microstructure through mechanicalthermal treatment of this intermetallic alloy (in collaboration with Yokohama University).

FIELDS OF RESEARCH RESULTS APPLICATION

Basic Research:

- Transferability of fracture mechanical data for steels
- Evaluation and explanation of fracture behaviour of ceramic matrix composites
- Explanation and knowledge systemisation on low temperature fracture of titanium aluminides

Applied research:

- Biomedicine / prosthetics (biocompatible highly porous glass for tissue engineering – collaboration with Imperial College London)
- Aerospace industry (glass for extreme conditions: glass ceramics reinforced by fibres, transparent armour)

» Fracture resistance of containers for spent nuclear fuel (NATO project coordinated by the group leader)
» Railway crossing points – bainitic steel and fracture resistance evaluation (DT – Vyhýbkárna a strojírna, Prostějov)

NUMBER OF RESEARCH POSITIONS ↘

SENIOR RESEARCH STAFF

5

JUNIOR RESEARCH POSITIONS (INCL. PH.D. STUDENTS):

6

KEY RESEARCH EQUIPMENT ↘

LIST OF DEVICES

» 3 Screw driven testing machine (ZWICK, Instron) for loadings up to 200 kN, temperatures from -198 to +1200 °C, fixtures for tensile, three/four point bend test, compact tension, compression etc. for steels, ceramics, intermetallics and their composites, selection of different extensometers and strain gauges
» 1 hydraulic test machine for loading rates up 6 m/s
» 3 instrumented impact pendulums with different impact energy and devices for testing different materials
» Instrumented indentation tester (including ball indentation test)
» MTS microtester for loadings from mN to 200 N
» Measuring work-station, universal test and evaluation software, both commercial and developed by laboratory
» Image analysis and digital image correlation techniques for local deformation determinations
» Confocal microscope with built-in atomic force microscope

BUDGET ↘

TOTAL (MIL. CZK/ MIL. EUR)

7 / 0.28

PART OF THE TOTAL BUDGET FROM PRIVATE RESOURCES (%)

5

PART OF THE TOTAL BUDGET FROM FOREIGN RESOURCES (%)

10

MAIN PROJECTS ↘

2010–2012: Fracture behaviour prediction based on quantification of local material response (Czech Science Foundation, GAP108/10/0466)

2010–2012: Microstructural design of high toughness materials (Czech Science Foundation, GAP107/10/0361)

2009–2012: Mechanical and fracture properties of multilayered ceramic/ceramic and ceramic/metal materials with graded layers (Czech Science Foundation, GA101/09/1821)

2009–2011: Development of new matrix types based on pyrolysed resins for composites reinforced with ceramic fibres (Czech Science Foundation, GA106/09/1101)

2008: Study of the micromechanisms of cleavage fracture of 14% Cr ODS ferritic steels (Euratom EFDA project)

2011-2014: GlaCERCo: Glass and Ceramic Composites for High Technology Applications – Initial Training Network (project 264526 financed by the 7FP EU)

MAIN COLLABORATING PARTNERS ↘

COLLABORATION WITH ACADEMIC PARTNERS

» Faculty of Mechanical Engineering, Brno University of Technology (NETME Centre, Brno, CZ)
» Faculty of Chemistry, Brno University of Technology (Brno, CZ)
» University of Mining - Technical University (Ostrava, CZ)
» Faculty of Mechanical Engineering, Czech Technical University (Prague, CZ)
» University of Metz (FR)
» University of Miscolc (HU)
» Imperial College London (GB)
» University of Erlangen (DE)
» Institute of Inorganic Chemistry, Slovak Academy of research (SK)

COLLABORATION WITH COMPANIES

» Schottglass Meinz (DE)
» Siemens (Brno, CZ, DE)
» DT – Výhybkárna a strojírna (Prostějov, CZ)
» KMM Vin (Virtual European Institute)
» EURATOM (EFDA, F4E)

EXPECTATIONS ↘

REQUIREMENTS

We are looking for collaboration with academic and industrial partners (Czech and foreign too) in the field of advanced materials including ceramic matrix composites.

OFFERS

» High quality research work in the field of materials fracture linked to advanced materials development and/or operational degradation analyses. Research of basic and applied type. We can mainly offer service for development centres and specialized firms
» Contacts to other laboratories (including laboratories joined in KMM-VIN Virtual European Institute
» Excellent conditions for training through research of PhD students and young scientists

04 / 2011