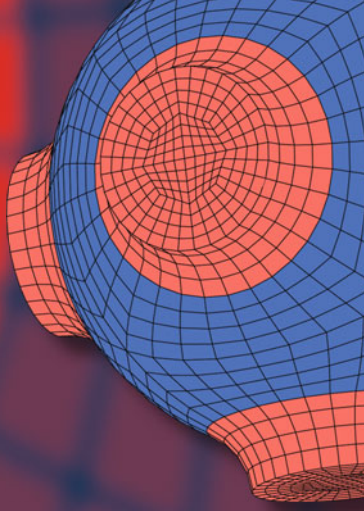
Advanced Structured Materials



Wolfgang H. Müller
Alfons Noe
Ferdinand Ferber *Editors*

# New Achievements in Mechanics

## A Tribute to Klaus Peter Herrmann

Springer

# Advanced Structured Materials

Volume 205

Common engineering materials are reaching their limits in many applications, and new developments are required to meet the increasing demands on engineering materials. The performance of materials can be improved by combining different materials to achieve better properties than with a single constituent, or by shaping the material or constituents into a specific structure. The interaction between material and structure can occur at different length scales, such as the micro, meso, or macro scale, and offers potential applications in very different fields.

This book series addresses the fundamental relationships between materials and their structure on overall properties (e.g., mechanical, thermal, chemical, electrical, or magnetic properties, etc.). Experimental data and procedures are presented, as well as methods for modeling structures and materials using numerical and analytical approaches. In addition, the series shows how these materials engineering and design processes are implemented and how new technologies can be used to optimize materials and processes.

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Ferdinand Ferber
Editors

# New Achievements in Mechanics

## A Tribute to Klaus Peter Herrmann

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*Dedicated to the memory of a creative scientific spirit, Klaus Peter Herrmann*

# Foreword

Klaus Peter Herrmann
(1937–2023)

Klaus Peter Herrmann was born in Königszelt, district of Scheidnitz, Lower Silesia (now Poland) on May 20, 1937. He passed away on March 14, 2023, in Paderborn (Germany). He retired from the Universität Paderborn in 2002, which he had joined as a Full Professor and Chair in 1977, and where he founded the LTM—Laboratorium für Technische Mechanik. His longstanding scientific activity in Fracture and Composite Mechanics—both experimental and theoretical—is well known in the Community of Mechanics, Mathematics, and Physics. In these fields, he enjoys a well-established reputation.

Throughout his work, eigenstresses in materials and their consequences in engineering were the paramount topic. This lifelong endeavor started with the defense of his Ph.D. thesis in 1963 under the supervision of Prof. Hieke at the Universität Halle-Wittenberg. It continues in his habilitation thesis—also accompanied by Prof. Hieke. During his time in Paderborn, more than 300 papers on the subject resulted and more than ten Ph.D. theses were supervised by him.

K. P. Herrmann was the editor of several monographs on failure of composites and a member of various scientific organizations, such as the Gesellschaft für Angewandte

Mathematik and Mechanik (GAMM) and the New York Academy of Science. He was a host to many international scientists for whom the LTM became a second home. He also organized the annual international workshop *AG Composite* at the Liborianum in Paderborn—an unforgotten event for every participant.

He will remain in the memories of his many friends and colleagues in the Scientific Community.

Berlin, Soest, Paderborn, Germany
January 2024

Wolfgang H. Müller
Alfons Noe
Ferdinand Ferber

# Preface

Immediately after the unexpected death of Klaus Peter Herrmann, invitation letters for a special memorial volume were sent to his many friends and colleagues—scientists working in the fields of Continuum Mechanics (or more general Continuum Physics).

The nineteen papers compiled in this book are the result of this call. They can be categorized into

- General continuum physics
- Fracture and damage mechanics
- Composites
- Experimental mechanics

Of particular interest is an article on K. P. Herrmann's eventful life, which also contains a full list of his publications.

The editors would like to thank all contributors for their dedicated work. Moreover, we gratefully acknowledge Prof. Dr. hc. mult. Holm Altenbach and Dr. Christoph Baumann (Springer Publisher) for their support of the book project.

Berlin, Soest, Paderborn, Germany
January 2024

Wolfgang H. Müller
Alfons Noe
Ferdinand Ferber

# Contents

# The Scientific Work of K. P. Herrmann

**Wolfgang H. Müller, Alfons Noe, and Ferdinand Ferber**

**Abstract** In this article we present some information about the life and the scientific work of the late Prof. K. P. Herrmann. It contains various details regarding his scientific education, the academic institutions he was affiliated with, the principal direction of his research, his Ph.D. students, and a (hopefully) complete list of his scientific publications, which got lost after his retirement from the Universität Paderborn and which is recompiled here for the first time.

## 1 Beginnings and Scope of Scientific Work of K. P. Herrmann

Klaus Peter Herrmann (or K. P. Herrmann for short) was born on May 20, 1937 in Königszelt, district of Scheidnitz, Lower Silesia, now Poland (Fig. 1). After the invasion of Silesia by the Red Army in 1945 his family were forced to leave immediately. Finally, after a very stressful and dangerous escape through the Sudetenland (now Czechia) and Bavaria they managed to settle in Halle in East Germany, which was then under the occupation of the Soviets. In 1949 these passed on power to the German communists, who brought oppression and dictatorship of the people to perfection. Because he and his family showed a free and independent spirit they never could, nor ever would, agree to tyranny. Of particular importance to him was the right for free travel and exchange of scientific ideas. Indeed, he

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**Fig. 1** Klaus Peter Herrmann 19–2023

started his scientific career at the Martin-Luther Universität Halle-Wittenberg at the Mathematisch-Naturwissenschaftliche Fakultät. By education and way of thinking he was a true physicist, with a strong affinity toward mechanics—in particular continuum mechanics—but open-minded to the needs of the engineering community. In fact his main field of research was in fracture mechanics, namely fracture due to thermal and other eigenstrains, with major engineering applications to fiber reinforced composites, which were of current interest at that time. The beginnings of his work are in linear elasticity, always accompanied by a strong touch of applied mathematics, and with a perspective into non-linear material behavior, specifically (visco-) plasticity.

This becomes evident from the title of his Ph.D. thesis (defense in 1963, publication in 1964) *Über ein elastisch-inelastisches Problem bei Vorhandensein von Eigenspannungen* (On an elastic-inelastic problem during the presence of eigenstresses) and his habilitation work in theoretical physics (1969) *Einige Beiträge zur Kontinuumstheorie der durch wohldefinierte Inkompatibilitätsverteilungen verursachten Eigenspannungen* (Some contributions of continuum theory on eigenstresses resulting from well-defined incompatibility distributions).

Of course, scientific thinking at the university was observed and controlled by the Stasi. They quickly realized that K. P. Herrmann was an "unsecure candidate." Infamy reached a climax when they suggested that he should go to Russia for further studies. We would probably call such a sojourn a Postdoc now, but the term they used was *Aspirantur*, following Soviet terminology. Of course, the idea of the Stasi was to "adjust" K. P. Herrmann's mind and to make him realize how wonderful communism really is. Naturally this generous offer he respectfully declined, and in

1970 he insisted on going to the Polish Academy of Science in Warsaw to the Chair of Witold Novacki instead. Poland was already then very different from the other satellite states of the Soviet Union. The Polish always thought of themselves as being special and independent, and had continued to fight for their freedom ever since the days of Kościuszko. It is therefore not surprising that in Warsaw, much different from East Germany, he found many like-minded people, who would stay his friends and scientific colleagues for the rest of life (see the publication list). Breathing a somewhat free air for the first time, and enviously realizing that the Polish colleagues were allowed to travel to the West, especially also to America, he and his wife, Dr. Rosel Herrmann, made up their mind to leave East Germany for good. This meant to give up a secure and prestigious position of a *Privatdozent* in Halle-Wittenberg in exchange for freedom. Therefore, in 1971 they secured an invitation from Heinz Parkus to give presentations at the Technical University of Vienna, booked return (!) flights and saw their luggage already being uploaded to the Austrian airplane, when they suddenly felt the arms of Polish security on their shoulders. What was missing was a stamp from the East German Embassy granting free passage. So the Poles called East German representatives, the luggage was unloaded, and he and his wife were first brought to East Berlin and then to the *Roter Ochse* prison in Halle, at that time still unchained.

At the *Roter Ochse* they both faced several months of pretrial detention under horrible sanitary conditions. Finally, in November of 1971 his wife was sentenced to "only" two years of prison (which made her "only" a delinquent in the East German eyes) and he, being considered as the leader of the whole operation, to two years and nine months of prison, which turned him into a criminal for East Germans. His wife was taken to the infamous penitentiary for women in Hoheneck and he to Cottbus Lager, this time in chains. Luckily the West German government started to negotiate through the sleazy, but effective East Berlin attorney Wolfgang Vogel for ransom release with the Stasi immediately. Moreover in 1972 the East German regime was showing good will in the interest of a smooth signing of the *Grundlagenvertrag*. So they officially declared a general pardon including political prisoners, because of the 23 year celebration of the founding of the "DDR." This being a blessing in disguise, both Herrmanns were released after ca. one year of imprisonment.

They immediately went to West Germany to rejoin with family. In particular, his father, being old and thus expendable in the mind of communists, had lived there for several years by now. So K. P. Herrmann managed to resume his scientific career at the famous Universität Karlsruhe (now Karlsruhe Institute of Technology—KIT). There he joined the faculty at the Institut für Technische Mechanik und Festigkeitslehre in 1972 as a *Privatdozent*.

In 1973 he accomplished to change his *venia legendi* from theoretical physics to the field of mechanics and, after his appointment as *außerplanmässiger Professor* (extracurricular professor) in 1975, he took over the duties of the chair held by Prof. Lippmann on a deputy basis. In 1977 he was finally appointed to Full Professor and Chair at the newly founded Universität Paderborn. There he established his own laboratory and research group—the *Laboratorium für Technische Mechanik—LTM*.

It is fair to say that his origin as a theoretical physicist haunted him to the very end at the local engineering department. Unfortunately, (theoretical) physicists are perceived as "dangerous" and "strange" by engineers, which could be due to their strong mathematical knowledge most engineers shun and despise. But it is also fair to say that K. P. Herrmann got never tired to stress that "physicists are the salt of the Earth" and remained true to his beliefs. Moreover, it is doubtless a merit of K. P. Herrmann that in his laboratory versatile minds educated in mechanical engineering, applied mathematics and theoretical physics from Germany and many other countries met and benefited from each other for the advancement of science, as documented hereafter.

## 2 Ph.D. Students

K. P. Herrmann's interest in thermal fracture manifests itself in the supervision of the theses of his thirteen Ph.D. students. Their work encompasses both, *theoretical* as well as *experimental* research in that field. Both branches were *equally* important to him:

1. Hans Peter Braun (1979) *Theoretische und experimentelle Untersuchungen zum Problem der quasistatischen Rissausbreitung in eigengespannten Zweikomponentenwerkstoffen*.
2. Hans Grebner (1983) *Bruchmechanische Untersuchungen zur Ausbreitung von Wärmespannungsrissen in spröden Mehrkomponentenmedien*.
3. Ferdinand Ferber (1986) *Bruchmechanische Analyse der Entstehung und Ausbreitung von Matrix- und Grenzflächenrissen in thermisch belasteten Faserverbundwerkstoffmodellen*.
4. Peter Pawliska (1988) *Finite-Element-Analyse rißbehafteter Modellsysteme von unidirektional verstärkten Faserverbundwerkstoffen unter Berücksichtigung des durch Wärmespannungen induzierten Plastifizierungs- und Kriechverhaltens des Matrixmaterials*.
5. Ming Dong (1993) *Untersuchungen zur Wärmespannungsrißausbreitung in zwei- und dreidimensionalen Modellkörpern von Schichtverbundwerkstoffen*.
6. Olaf Hinz (1993) Experimentelle und numerische Analyse von Rißspitzenspannungsfeldern mit Hilfe der digitalen Bildanalysetechnik.
7. Wolfgang Meiners (1994) *Über die Anwendung singulärer Integralgleichungen zur Untersuchung des Spannungszustandes in rissbehafteten diskontinuierlich inhomogenen Kontinua unter thermomechanischer Belastung*.
8. Alfons Noe (1994) *Zur dynamischen Ausbreitung gerader und gekrümmter Grenz-flächenrisse in thermomechanisch belasteten Bimaterialien: Ein Beitrag zur Grenzflächenmechanik*.
9. Thorsten Hauck (1997) *Bruchmechanische Bewertung thermisch eigengespannter Grenzflächenrisse in elastoplastischen Bimaterialien*.

10. Bernd Potthast (1998) *Zur dynamischen Rißausbreitung im drucksensiblen porösen elastoplastischen Festkörper bei Verwendung unterschiedlicher Materialmodelle*.
11. Klaus Linnenbrock (2000) *Zur Analyse thermisch induzierter dreidimensionaler Eigenspannungsrisse in räumlichen Verbundwerkstoffmodellen unter Verwendung numerischer und experimenteller Methoden*.
12. Van-Son Nguyen (2004) *Zur experimentellen Erfassung mechanischer Kenndaten thermo-mechanisch gealterter SMT-Lotwerkstoffe mit Hilfe des Small Punch Tests*.
13. Stefan Neumann (2004) *Anwendungen der diskreten Fourier-Transformation zur Entwicklung numerischer Algorithmen in der Mikromechanik*.

K. P. Herrmann's work in thermal fracture is reflected in two edited monographs and more than one hundred peer-reviewed and proceedings papers each in that field:

## 3 Books and Monographs

1. Herrmann, K. (1964). Über ein elastisch-inelastisches Problem bei Vorhandensein von Eigenspannungen, Martin-Luther Universität Halle-Wittenberg, Math.-naturwiss. Fakultät, Dissertation, April 06, 1964.
2. Herrmann, K. (1969). Einige Beiträge zur Kontinuumstheorie der durch wohldefinierte Inkompatibilitätsverteilungen verursachten Eigenspannungen, Martin-Luther Universität Halle-Wittenberg, Math.-naturwiss. Fakultät, Habilitation Thesis, September 29, 1969.
3. Herrmann, K. P., Larsson, L. H. (Eds.). (1987). Fracture of Non-Metallic Materials: Proceedings of the 5th Advanced Seminar on Fracture Mechanics, Joint Research Centre, Ispra, Italy, 14–18 October 1985 in collaboration with the European Group on Fracture. Springer Science & Business Media.
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5. Vollertsen, F., Hahn, O., Herrmann, K. P., Meier, H. J. (Eds.). (2000). Endeigenschaftsnahe Formgebung—Fertigung und Bauteilprüfung. Shaker Verlag.

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8. Herrmann, K. P. (1970). Über Eigenspannungen im diskontinuierlich inhomogenen Festkörper. 11. Exzentrische Lage der Teilgebiete. Schriftenreihe der DAW Berlin: Beiträge zur Spannungs- und Dehnungsanalyse, Heft VI, 41–52.
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