European Physical Society
Nuclear Physics Division

Klaus Bethge/Horst Baumann
Hartmut Jex/Friedrich Rauch (Eds.)

Nuclear Physics Methods in Materials Research

Proceedings of the Seventh Divisional Conference
Darmstadt, September 23-26, 1980

With 301 Figures

Universitätsbibliothek und TIB
Welfengarten 1B
3000 Hannover 1

Friedr. Vieweg & Sohn  Braunschweig/Wiesbaden
**TABLE OF CONTENTS**

**INVITED PAPERS**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOME DEVELOPMENTS AND IMPASSES IN MATERIAL SCIENCE, RELATED TO INSTRUMENT PROGRESS</td>
<td>1</td>
</tr>
<tr>
<td>J. Philibert</td>
<td></td>
</tr>
<tr>
<td>NEUTRON SCATTERING APPLIED TO PROBLEMS IN MATERIALS RESEARCH</td>
<td>9</td>
</tr>
<tr>
<td>W. Schmatz</td>
<td></td>
</tr>
<tr>
<td>NEUTRON PHYSICS AND NEUTRON SCATTERING - TRENDS IN APPLICATIONS TO MATERIALS SCIENCE</td>
<td>21</td>
</tr>
<tr>
<td>J.W. White</td>
<td></td>
</tr>
<tr>
<td>MICROMETALLURGY BY ION IMPLANTATION</td>
<td>56</td>
</tr>
<tr>
<td>G. Dearnaley</td>
<td></td>
</tr>
<tr>
<td>THIN LAYER ACTIVATION TECHNIQUE AND WEAR MEASUREMENTS IN MECHANICAL ENGINEERING</td>
<td>70</td>
</tr>
<tr>
<td>G. Essig and P. Fehsenfeld</td>
<td></td>
</tr>
<tr>
<td>MATERIALS ANALYSIS USING FAST CHARGED PARTICLES</td>
<td>82</td>
</tr>
<tr>
<td>P. Müller</td>
<td></td>
</tr>
<tr>
<td>DEPTH PROFILING OF LIGHT ISOTOPES BY USE OF NUCLEAR REACTIONS</td>
<td>101</td>
</tr>
<tr>
<td>J. Böttiger</td>
<td></td>
</tr>
<tr>
<td>APPLICATION OF THE CHANNELLING TECHNIQUE IN MATERIALS RESEARCH</td>
<td>115</td>
</tr>
<tr>
<td>O. Meyer</td>
<td></td>
</tr>
<tr>
<td>NEW DEVELOPMENTS IN ACTIVATION ANALYSIS</td>
<td>129</td>
</tr>
<tr>
<td>Ch. Engelmann</td>
<td></td>
</tr>
<tr>
<td>APPLICATIONS OF THE PIXE TECHNIQUE AND OF NUCLEAR MICROBEAMS</td>
<td>145</td>
</tr>
<tr>
<td>J.A. Cookson</td>
<td></td>
</tr>
</tbody>
</table>
PERTURBED ANGULAR CORRELATIONS AS A TOOL IN SOLID STATE PHYSICS  
M. Forker  

VACANCY TRAPPING IN fcc METALS STUDIED BY PERTURBED ANGULAR CORRELATIONS  
F. Pleiter  

MOSSBAUER SPECTROSCOPY IN MATERIALS RESEARCH  
Ch. Janot  

IMPLANTATION AND DEFECT STUDIES BY MOSSBAUER SPECTROSCOPY  
B.D. Sawicka  

POSITRONS AS SOLID STATE PROBES  
R.N. West  

POSITIVE MUONS IN METAL PHYSICS  
E. Karlsson  

POSITIVE PIONS AS PROBES IN CRYSTAL PHYSICS  
K. Maier  

MICROTOOLING AND MICROSCOPY WITH HEAVY IONS SOME EXAMPLES OF APPLIED RESEARCH AT GSI  
B.E. Fischer and R. Spohr  

INSTRUMENTATION FOR CHEMICAL AND STRUCTURAL ANALYSIS IN MATERIALS SCIENCE AND NUCLEAR PHYSICS - A CONFERENCE SUMMARY  
H. Fischmeister
TIME-DEPENDENT NEUTRON DEPOLARIZATION - A NOVEL METHOD IN MAGNETIC MATERIALS RESEARCH
G. Badurek and J. Hammer 306

NEUTRON TIME-OF-FLIGHT (TOF) DIFFRACTOMETRY FOR THE DETERMINATION OF THE MAGNETIC MOMENT DIRECTION IN POLYCRYSTALLINE MATERIALS
I. Sosnowska and E. Steichele 309

DETERMINATION OF THE ASPHALT CONTENT IN BITUMINOUS MIXTURES BY NEUTRON THERMALIZATION
E. Chruściel, J. Gyurcsak, R. Krasowski, A. Kreft and J. Woźniak 312

DYNAMIC NEUTRON DEPOLARIZATION AND SMALL-ANGLE SCATTERING STUDIES OF THE SUPERPARAMAGNETIC SYSTEM Cu-1%Co
G. Badurek, J. Hammer, H. Rauch and J. Schelten 315

NEUTRON DIFFRACTION STUDIES OF POLYCRYSTALLINE MATERIALS
A. Oleś and J. Szpunar 319

INFLUENCE OF RADIATION DAMAGE ON THE SUPERCONDUCTIVITY AND ELECTRICAL PROPERTIES OF RHENIUM THIN FILMS
A. ul Haq and O. Meyer 322

RESISTIVITY- AND Tc-CHANGES PRODUCED IN INDIUM-FILMS BY LOW TEMPERATURE Ar+-IRRADIATION
A. Hofmann, P. Ziemann and W. Buckel not received

NOVEL DEVELOPMENTS IN SURFACE ACTIVATION
J. Asher and T.W. Conlon 325

MATERIALS TRANSFER STUDIES IN ENGINEERING TEST LOOPS
D. Gibbons and J.W. Haynes 328
STUDIES ON THE ELABORATION AND THE CHARACTERIZATION
OF GaAs BY RADIOACTIVATION ANALYSIS WITH CHARGED PARTICLES
C. Koemmerer, M. Valladon, A. Giovagnoli, G. Blondiaux,
J.L. Debrun, G. Jacob, J. Hallais and G. Poiblaud 331

SOLID SOLUTIONS OF Transition Metals IN HIGH PURITY SILICON
STUDIED BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS (INAA)
AND ELECTRON PARAMAGNETIC RESONANCE (EPR)
N. Wiehl, U. Herpers and E. Weber 334

ELASTIC SCATTERING AND NUCLEAR REACTION TECHNIQUES AS A
TOOL TO MEASURE DEPTH DISTRIBUTIONS IN SOLIDS
J. Berthold, H. Damjantschitsch, F.-J. Demond, H.P. Frerichs,
S. Kalbitzer, H. Mannsperger, G. Müller, M. Reinelt,
and J. Wittner not received

ANALYSIS OF HYDROGEN IN SOLIDS WITH THE $^{15}$N METHOD
H. Baumann, U. Behrens, K. Bethge, F. Rauch, H. Schwenk,
B. Streb and W. Strohl 337

INTERACTIONS BETWEEN THE DIFFERENT CHEMICAL SPECIES
IN SPUTTERED SILICON AMORPHOUS STRUCTURE
M. Toulemonde, J.J. Grob, P. Siffert;
A. Deneuville and J.C. Bruyere 340

SURFACE STOCHIOMETRY AND CARBON DISTRIBUTION IN
MERCURIC IODIDE BY ION ANALYSIS
C. Scharager, A. Tadjine, M. Toulemonde, J.J. Grob and P. Siffert 343

HYDROGEN MOBILITY UNDER BEAM IMPACT WHEN USING THE
$^1$H ($^{15}$N, $\alpha$Y) NUCLEAR REACTION FOR MATERIAL ANALYSIS
J.P. Thomas, M. Fallavier and J. Touset 346

DETRAPPING AND OUTDIFFUSION OF 300-keV DEUTERONS IMPLANTED
INTO NICKEL AND PALLADIUM
Th. Pfeiffer and W. Müller not received
ELASTIC BACKSCATTERING AND RECOIL DETECTION ANALYSIS
USING A 6MV TANDEM ACCELERATOR
C. Nölscher, W. Schmidt, K. Brenner, V. Brückner, M. Lehmann,
P. Müller and G. Saemann-Ischenko

RBS-ANALYSES WITH PROTONS $200 \leq E_p \leq 400$ keV
A. Heller, H. Mommsen and W. Sarter

TEMPERATURE DEPENDENCE OF FERROMAGNETISM AT GD SURFACES
DETERMINED WITH ELECTRON CAPTURE SPECTROSCOPY ECS
S. Eichner and C. Rau

RADIOISOTOPE DATING USING AN EN-TANDEM ACCELERATOR
G. Bonani, R. Balzer, M. Suter and W. Höflfl
J. Beer, H. Oeschger and B. Staufer

SPIN POLARIZATION OF ELECTRONS AT SURFACES OF OLIGATOMIC
EPITAXIAL Ni(100)-LAYERS
C. Rau and G. Eckl

EVALUATION OF ION BEAM SPECTRA FOR SURFACE
ANALYSIS OF PROBES EXPOSED IN FUSION DEVICES
P. Børgesen, R. Behrisch and B.M.U. Scherzer

RBS, COULOMB EXCITATION γ-RAYS, AND X-RAY PRODUCTION
STUDIED IN CHANNELING CONDITIONS
S. Kopta, R. Hajduk, A.Z. Hryniewicz,
E. Maydell-Ondrusz and B. Rajchel

LOCATION OF CHEMISORBED OXYGEN ON NiFe(110) BY
SURFACE CHANNELING
W. Graser and C. Varelas

LOCATION OF ADSORBED FOREIGN ATOMS BY
SURFACE CHANNELING
C. Varelas and H.D. Carstanjen
STUDY OF THE COOPERATIVE JAHN - TELLER PHASE TRANSITION IN CESIUM COPPER CHLORIDE BY CHANNELING OF HE - IONS

LOCATION OF ADSORBED FOREIGN ATOMS ON CRYSTAL SURFACES BY FAST ION CHANNELING IN TRANSMISSION
H.D. Carstanjen

APPLICATION OF PARTICLE CHANNELING TO THE STUDY OF GADOLINIUM GALLIUM GARNETS : Mg, Zr

STUDY OF THE TEMPERATURE DEPENDENCE OF THE MINIMUM YIELD IN BaTiO₃ IN THE TEMPERATURE REGION FROM 295 K - 425 K

DETERMINATION OF VIBRATIONAL AMPLITUDES OF IMPURITIES IN METALS BY FAST ION CHANNELING: D in Pd and O in Nb
H.D. Carstanjen

STANDARDLESS PIXE BULK ANALYSES AT LOW AND HIGH ENERGIES AND ARCHAEOMETRIC APPLICATIONS
H. Mommsen, M. Sarkar and W. Sarter

CORRELATION BETWEEN WIND-DIRECTION AND ELEMENTAL COMPOSITION OF ATMOSPHERIC AEROSOLS, DETERMINED BY PIXE

APPLICATION OF PIXE METHOD TO COAL ANALYSIS
J. Bujok, L. Jarczyk, E. Rokita, D. Sjomińska and A. Strzajkowski

PIXE, A METHOD OF HIGH SENSITIVITY FOR MULTI-ELEMENTAL ANALYSIS OF THIN SAMPLES AND SURFACE LAYERS
F. Gloystein, H. Jupe, F.-W. Richter and U. Wätjen
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMPLE PROCEDURE FOR THICK SAMPLE PIXE DATA ANALYSIS</td>
<td>R.P.H. Garten, K.O. Groeneveld and K.-H. König</td>
<td>402</td>
</tr>
<tr>
<td>THE ELECTRIC QUADRUPOLE INTERACTION IN NONCUBIC FLUORIDES AND OF RADIATION INDUCED LATTICE DEFECTS IN CUBIC FLUORIDES</td>
<td>H. Barfuß, G. Böhnlein, H. Hohenstein, W. Kreische, H. Niedrig and A. Reimer</td>
<td>404</td>
</tr>
<tr>
<td>DEFECTS CREATED BY INDIUM IMPLANTATION IN MAGNESIUM OXYDE CRYSTALS</td>
<td>L. Fritsch, G. Marest and A. Perez</td>
<td>411</td>
</tr>
<tr>
<td>THE ELECTRIC FIELD GRADIENT AND THE TEMPERATURE VARIATION ON $^{111}$Cd IN Re AND Zr hcp METAL HOSTS</td>
<td>L. Hermans, M. Rots, G.N. Rao, J. Claes and R. Coussement</td>
<td>not received</td>
</tr>
<tr>
<td>INVESTIGATION OF LATTICE DEFECTS IN HCP METALS</td>
<td>R. Keitel, W. Engel, S. Hoth, W. Klinger, R. Seeböck, and W. Witthuhn</td>
<td>415</td>
</tr>
<tr>
<td>TRAPPING OF VACANCIES AT $^{111}$IN-IMPURITIES IN COLD WORKED ALUMINIUM</td>
<td>H.G. Müller</td>
<td>418</td>
</tr>
</tbody>
</table>
MEASUREMENT OF DEBYE TEMPERATURES OF Mg$_2$Ni, Mg$_2$NiH$_4$ AND Mg$_2$NiD$_4$ USING RESONANT SCATTERING OF GAMMA RAYS
I. Jacob, M.H. Mintz, O. Shalal and A. Wolf

MOSSBAUER EFFECT STUDY OF CHARGE AND SPIN TRANSFER IN Fe-Cr ALLOYS
S.M. Dubiel and J. Zukrowski

ANISOTROPY OF THE DIFFUSIONAL BROADENING OF THE MOSSBAUER RESONANCE IN Al $^{57}$Co/$^{57}$Fe
S. Mantl, W. Petry and G. Vogl

MOSSBAUER CONVERSION ELECTRON AND RUTHERFORD BACKSCATTERING ANALYSIS OF LASER-IMPLANTED Fe and Sn IN SILICON

SUPERPARAMAGNETISM OF VERY SMALL COBALT PARTICLES STUDIED BY MOSSBAUER SPECTROSCOPY
J. Korecki and K. Krop

AN INVESTIGATION BY MOSSBAUER SPECTROSCOPY OF SPIN ARRANGEMENTS IN THE β-PHASE OF Fe-Ge
J.M. Daniels, H-Y Lam and P.L. Li

MAGNETIC HYPERFINE FIELD DISTRIBUTION IN SOME AMORPHOUS FERROMAGNETIC IRON ALLOYS
S. Dey, M. Rosenberg and F.E. Luborsky

INFLUENCE OF CHROMIUM ON Sn SITE HYPERFINE MAGNETIC FIELDS IN Fe-Cr ALLOYS
S.M. Dubiel

RADIOGENIC DEFECTS IN SEMICONDUCTORS
G. Weyer, S. Damgaard and J.W. Petersen
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOPING OF COMPOUND SEMICONDUCTORS BY IMPLANTATION OF RADIOACTIVE IONS DECAYING TO A MOSSBAUER ISOTOPE</td>
<td>J.W. Petersen, S. Damgaard, J. Heinemeier and G. Weyer</td>
<td>448</td>
</tr>
<tr>
<td>QUADRUPOLE INTERACTION OF $^{125}$Te AND $^{129}$I IN Te IMPLANTED SEMICONDUCTORS</td>
<td>J. De bruyn, R. Coussement, I. Dëzsi, G. Langouche</td>
<td>451</td>
</tr>
<tr>
<td>POSITRON STUDY OF RADIATION DAMAGE IN NEUTRON-IRRADIATED IRON-CARBON SYSTEM</td>
<td>P. Hautojärvi, J. Johansson, L. Pöllänen, A. Vehanen, J. Yli-Kauppila, and P. Moser</td>
<td>454</td>
</tr>
<tr>
<td>POSITRON ANNIHILATION STUDY OF VOIDS IN ALUMINIUM</td>
<td>D. Segers, F. Van Brabander, L. Dorikens-Vanpraet, A. Deruytter, M. Dorikens; J. Cornelis and J. Nihoul</td>
<td>457</td>
</tr>
<tr>
<td>POSITRON ANNIHILATION IN NON-DESTRUCTIVE TESTING</td>
<td>A.E. Hughes, C.F. Coleman and F.A. Smith</td>
<td>460</td>
</tr>
<tr>
<td>DOPPLER BROADENING AND ANGULAR CORRELATION MEASUREMENTS OF POSITRON ANNIHILATION RADIATIONS IN MIXED VALENCE COMPOUNDS OF Sm</td>
<td>C.S. Sundar, B. Viswanathan, A. Bharathi and K.P. Gopinathan</td>
<td>464</td>
</tr>
<tr>
<td>VOID SWELLING AND VACANCY MIGRATION IN $\alpha$-Fe</td>
<td>L. De Schepper, G. Knuyt and L. Stals</td>
<td>468</td>
</tr>
<tr>
<td>MUON KNIGHT SHIFT STUDIES IN METALS</td>
<td>F.N. Gygax, A. Hintermann, W. Rüegg, A. Schenck and W. Studer</td>
<td>471</td>
</tr>
<tr>
<td>MUONIUM IN SEMICONDUCTORS</td>
<td>A. Weidinger</td>
<td>not received</td>
</tr>
</tbody>
</table>
HEAVY ION INDUCED AUGER ELECTRON SPECTROSCOPY OF SOLIDS
W. Schmidt, V. Brückner, F. Bömmel, P. Müller,
G. Saemann-Ischenko and A. Zsida

CORROSION AND CATALYTIC PROPERTIES OF MATERIALS BOMBARDED WITH HEAVY IONS
G. K. Wolf, H. Ferber, H. Kasten and H. Folger

HEAVY ION PRODUCED RADIATION DAMAGE:
SWELLING AND PRECIPITATION IN METALS
K. Exel, W. Humbach, K.-H. Leister, U. Scheuer, K. Schmelz,
and K. Ehrlich

AUTHOR INDEX 481

PARTICIPANTS 484