HANS JÜRGEN GRABKE ČASTNI DOKTOR UNIVERZE V LJUBLJANI

HANS JÜRGEN GRABKE DOCTOR HONORIS CAUSA of THE UNIVERSITY of LJUBLJANA

Hans Jürgen Grabke je bil rojen 29. maja 1935 v Hamburgu, Nemčija, kjer je tudi maturiral. Kemijo je študiral na Univerzah v Göttingenu in Münstru ter diplomiral na Univerzi v Hamburgu. Leta 1962 je pridobil doktorat naravoslovnih ved na Univerzi v Münstru, leta 1971 je bil na Univerzi v Stuttgartu habilitiran za docenta in leta 1977 za profesorja za fizikalno kemijo na Univerzi v Dortmundu.

V letih 1962 – 1966 je bil podoktorski raziskovalec na Max-Planck-Institut für Physikalische Chemie v Göttingenu, kjer je pod vodstvom uglednega znanstvenika prof. C. Wagnerja sodeloval pri raziskavah temeljnih mehanizmov in kinetike heterogenih reakcij z opredelitvijo parcialnih reakcijskih korakov, ravnotežnih aktivnosti in sestave vmesnih produktov ter z izračunom termodinamičnih in kinetičnih zakonitosti reakcij.

V letu 1966 se je zaposlil na Max-Planck-Institut für Metallforschung v Stuttgartu in delal kot vodja skupine, ki je nadaljevala raziskovanje heterogenih reakcij. Leta 1972 je prešel na Max-Planck-Institut für Eisenforshung (MPIE) v Düsseldorfu, kjer je postal vodja oddelka za fizikalno kemijo. Na tem mestu se je njegovo raziskovalno delo postopoma močno razširilo z vključevanjem študentov diplomantov, doktorantov, podoktorskih in gostujočih raziskovalcev.

Bil je med pionirji raziskovanja ravnotežne površinske segregacije atomov nekovinskih elementov, ki so v

Hans Jürgen Grabke was born in 1935 in Hamburg, where he graduated from secondary school. He studied chemistry at the universities of Göttingen and Münster, and graduated from the University of Hamburg. He obtained a doctorate in natural sciences in 1962 at the University of Münster, was habilitated to assistant professorship at the University of Stutgarth in 1971 and to full professorship for physical chemistry in 1977 at the University of Dortmund.

In the years 1962-1966 he was with the Max-Planck Institut für Physikalische Chemie in Göttingen as post-doc researcher and was involved in the group of Prof. C. Wagner in investigations of mechanisms and kinetics of heterogeneus reactions through determination of partial reaction steps, equilibrium activities, composition of intermediate reaction products and the deduction of reactions thermodynamic and kinetic laws.

In the years 1966 to 1972 he was with the Max-Planck Institut für Metallforschung in Stutgart as leader of the group involved in investigations of heterogeneus equilibria and in 1972 he became head of the Dept. of Physicalische Chemie at the Max-Planck Institut für Eisenforschung (MPIE) in Düsseldorf. His scientific work increased gradually with the involvement in research projects of doctoral candidates, post -oc researchers and guest scientists.

α-železu raztopljeni v zelo majhni količini (pod 0,01 %). Za nekatere elemente je izmeril kinetiko segregacije, opredelil je vpliv različnih elementov in njihove koncentracije na geometrijsko porazdelitev atomov matične kovine in segreganta na površini ter v globino segregirane plasti. Interakcijo različnih segregiranih elementov je razložil s pojavom, ki ga je opredelil kot "site competition", ker je na površini kovine omejeno število mest, v katera se lahko vgnezdijo atomi segregantov. Podobne segregacije je odkril tudi na endogenih in eksogenih mejah v mikrostrukturi kovin in zlitin in tako postavil znanstveno podlago za razumevanje nekaterih pojavov degradacije kovin in zlitin, npr. večjo občutljivost za interkristalno korozijo in interkristalno krhkost ter manjšo odpornost proti zelo počasni deformaciji jekla pri temperaturi majhne gibljivosti atomov v kristalni mreži. Kvantitativno je opredelil spremembo proste energije in entropije površine zaradi segregacije. Odkril je, da je gonilna sila za segregacijo prosta energija površine, ki je najmanjša pri neki specifični geometrični porazdelitvi atomov matične kovine in segreganta, pri kateri so najmanjše površinske elastične napetosti in površinska energija. Pri raziskavah je uporabljal poleg standardnih tudi eksperimentalne metode, ki so se tedaj šele uvajale, npr.: spektroskopijo Augerjevih elektronov (AES), rentgensko fotoelektronsko spektroskopijo (XPS) in difrakcijo maloenergijskih elektronov (LEED).

Raziskoval je tudi mehanizem in kinetiko naogljičenja železa pri temperaturah od 800 °C do 1000 °C in ugotovil, da na oboje močno vpliva segregacija nekaterih elementov, ki so sicer v jeklih v masnih deležih pod 0,10 %, pa z ogljikom ne tvorijo kemijskih spojin. Taki elementi so npr.: baker, kositer in žveplo, katerih vir je tudi pretaljevanje jeklenih odpadkov. Ugotovil je, da se v naogljičevalni atmosferi z redukcijo ogljikovega monoksida generirajo prosti atomi ogljika, ki se adsorbirajo na površino kovine, raztopijo in difundirajo v notranjost zaradi razlike v aktivnosti. Vzporedno nastane tudi površinska segregacija atomov primesi, ki zavira adsorpcijo atomov ogljika na površino, zato je bolj počasen prenos ogljika iz atmosfere na površino kovine. Tudi v tem primeru je ustvaril znanstveno podlago za razlago, zakaj se ne dosegajo pričakovane lastnosti po utrditvi površine z naogljičenjem in kaljenjem, ki je nujno za zadostno obrabno trdnost nekaterih izdelkov, npr. zobatih koles v avtomobilskih menjalnikih.

Raziskal je kompleksne reakcije naogljičenje-oksidacija, oksidacija-sulfidizacija in oksidacija-kloriranje na površini zlitin zaradi problemov, ki so se pojavili predvsem pri napravah za sežig komunalnih odpadkov in zaradi večjih kemijskih obremenitev zlitin v petrokemijskih napravah. Določil je naravo in sestavo produktov reakcij ter za reakcije in za reakcijske produkte opredelil termokemične in termodinamične zakonitosti. Dosežki tega raziskovanja so bili temeljnega pomena pri razvoju novih, boljših zlitin.

H.J. Grabke was one of the pioneers of investigations of surface segregation of surface-active elements in solid solution in iron, also at levels as low as 0.01 wt. %. For some elements the segregation kinetics and the effect of their content on the geometrical distribution of segregant and mother-element atoms on the surface and in depth were determined. The interaction of different parallely segregating elements was explained in terms of the mechanism of site composition, as on the metal surface segregating atoms can be accomodated only on a limited number of sites. Similar segregation was also discovered on endogeneus and exogeneus surfaces inside the alloys and was the scientific basis for the explanation of some empirically observed degradation mechanisms of alloys, e.g. the increased susceptibility to intercrystalline corrosion and brittleness and lower creep resistance by a temperature of low mobility of atoms iron lattice. The change of surface entropy and free energy related to the segregation were established and it was shown that the driving force for segregation was the free energy which was the lowest by a specific ditribution of segregant and mother atoms on the alloy surface.

For the investigations, besides standard, also new methods, such as Auger electron spectroscopy (AES), X ray photo-electron spectroscopy (XPS) and low-energy electron difraction (LEED) were used.

In the research related to the mechanism and the kinetics of carburising of steel in temperature range 800 to 1000 °C it was established that both are strongly affected by the surface segregation of some elements found in steel in contents of 0.1 wt % and lower, who do not form carbide compounds, e.g. copper, tin and suphur. It was confirmed that free carbon atoms, generated by CO reduction, are adsorbed on the surface, dissolve and diffuse inside the steel. In parallel, a surface segregation of impurities is formed, which hinders the adsorption of carbon atoms on steel surface and decreases the carburising reaction rate. These findings helped to understand why for carburising steels the content of some elements should be kept as low as possible.

H.J. Grabke also investigated complex reactions, like carburising-oxidation, oxidation- sulphidisation and oxidation-chloridisation with the aim of explaining specific problems met in processing plants for waste incineration and because of the greater chemical sollicitation in industrial installations. He determinated the nature and the composition of reaction products and the reactions' thermochemical and thermodynamic rules.

Of the greatest importance was the discovery of the process of dusting of iron alloys in strongly reductive atmosphere at a temperature above aproximately 800 °C. The alloys are disintegrated into powder if the activity of carbon in atmosphere is greater than in iron carbide. The dusting is prevented with a surface layer of chromium oxide.

Zelo pomembno je njegovo odkritje upraševanja (angleško dusting) površine kovin. Ugotovil je, da zlitine železa v močno reduktivni atmosferi in temperaturi nad 800 °C razpadejo v prah, če je aktivnost ogljika v atmosferi tolikšna, da presega tisto v železovem karbidu. Odkril je tudi, da neprepustna plast kromovega oksida zlitino zavaruje proti upraševanju. Njegovo delo je postalo podlaga za razvoj novih zlitin in postopkov za povečanje njihove obstojnosti v napravah, ki obratujejo v močno reduktivnih atmosferah, ki vsebujejo tudi ogljik.

H. J. Grabke je dosegel pomembne znanstvene uspehe tudi pri raziskovanju drugih pojavov in reakcij, npr.: vpliv elektrodnih potencialov različnih faz in elementov v zlitinah na mehanizem korozijskih reakcij v različnih medijih; mehanizem in kinetika nadušičenja in razdušičenja α železa; prenos kisika iz atmosfere na površino kovin in nastanek kali oksidov; mehanizem in kinetika nastanka hidridov v zlitinah; kemisorpcija žvepla in njen vpliv na površinske reakcije na površini železa; difuzivnost metaloidov v različnih zlitinah; adsorpcija tujih atomov in adhezivnost kovinskih površin; mehanizem in kinetika nastanka karbooksidov in karbosulfidov na površini zlitin; prenos ogljika skozi oksidne sloje; nastanek spojin s površinsko segregacijo metaloidov; površinska reaktivnost intermetalnih spojin

H.J. Grabke's scientific achievements are also significant in investigations of other topics and reactions: e.g. the influence of the electrode potential of different phases in alloys' microstructure on the mechanism of corrosion reactions in different media; mechanism and kinetics of nitriding and denitritriding of iron α; transport of oxygen from atmosphere to the metal surface and formation of oxide nuclei; mechanism and kinetics of the formation of hydrides in alloys; chemisorbption of sulphur and its effect on reactions on iron surface; diffusion of metalloides in different alloys; adsorption of impurities atoms and adhesion on metallic surfaces; mechanism

v različnih atmosferah; fazne premene v oksidnih slojih, ki rastejo na površini zlitin; detekcija vodika v oksidnih slojih na površini kovin in drugih.

Dosežki pri tem raziskovanju so ga uvrstili med najbolj prodorne in produktivne raziskovalce reakcij in interakcij med površino kovin in različnimi atmosferami in tekočimi mediji. Njegova dejavnost ni ostala omejena na znanstveno raziskovanje in objavljanje znanstvenih del, bil je tudi mentor številnih doktorantov, organiziral je številne učne delavnice na temo reakcij med površino kovin in atmosferami, predsedoval je in bil član znanstvenega odbora številnih mednarodnih konferenc na temo znanosti o površinah ter o mejnih površinah in pripravil tudi številna uvodna in pregledna predavanja.

V letu 2003 obsega njegova biliografija nad 500 del, ki so bili objavljena v Nemčiji in v številnih drugih državah, npr. Franciji, ZDA, Angliji, Kitajski, Japonski, skandinavskih državah, Sloveniji in drugod. Njegova dela so bila izbrana za najboljši članek leta v več znanstvenih revijah. Za izvirna znanstvena odkritja je prejel številne nagrade in bil izvoljen za častnega člana Poljske akademije znanosti.

H. J. Grabke intenzivno sodeluje z raziskovalci v Sloveniji že od leta 1980 in nadaljuje tradicijo sodelovanja, ki ga je vzpostavil desetletja prej prof. C. Rekar, nestor slovenske metalurgije. Prof. Rekar je sodelavce s fakultete in inštituta pošiljal na MPIE na usposabljanje. Le-ti so nova spoznanja prenesli v Slovenijo in obogatili slovensko znanost na področju metalurgije in fizikalne kemije. S prihodom prof. Grabkeja se je sodelovanje okrepilo tudi z oživitvijo organizacije mednarodnih konferenc, ki so jih skupno začeli organizirati desetletja prej inštituti: IRSID iz Francije, MPIE iz Nemčije in takratni Metalurški inštitut, sedaj Inštitut za kovinske materiale in tehnologije Ljubljana. Tematika konferenc je bila vpliv elementov v sledeh (takrat smo jih poimenovali oligo ali rezidualni elementi) na površinsko aktivnost in lastnosti zlitin železa.

Prav nekaj let prej se je začel izreden razvoj znanosti o površinah z uporabo analitskih tehnik AES in XPS, ki so omogočale kvantitativne raziskave površinske segregacije in segregacije po mejah kristalnih zrn ter razlago fizikalno-kemijskih pojavov na površinah kovin in zlitin.

MPIE je bil med prvimi inštituti, ki so bili opremljeni z vrhunsko raziskovalno opremo. Prof. Grabke je omogočil slovenskim raziskovalcem dostop do te opreme, preskrbel jim je štipendije in omogočil usposabljanje v svojem oddelku za fizikalno kemijo. Slovenski raziskovalci so se tako seznanili z najnovejšimi dosežki na področju raziskav segregacij in z njihovim vplivom na rekristalizacijo, na razvoj teksture itd. Spoznali so se tudi z najnovejšimi dosežki na področju visokotemperaturne oksidacije površine kovin in zlitin, elektrokemije in korozije. Prav H. J. Grabkeju gre zahvala, da je bilo eksperimentalno delo za nekatera magistrska in doktorska dela, ki so jih kandidati zagovarjali na Univerzi v

and kinetics of the formation of carbooxydes and carbosulfides on alloys' surface; transport of carbon in oxide layers; formation of compounds with surface segregation of metalloides; surface reactivity of intermetallic compound alloys in different atmospheres; phase changes in oxide layers growing on alloys' surface; detection od hydrogen in oxyde layers on alloys surface and other topics.

By 2003, H.J. Grabke's bibliography contained more than 500 scientific articles printed in scientific journals or presented at scientific conferences in Germany and other countries, e.g. France, Great Britain, USA, China, Japan, Scandinavia, Slovenia and other countries. His works were selected as the best articles of the year in several journals, he was given prestigious awards for scientific achievements in several countries and elected to the Honoray Membership of the Polish Academy of Sciences.

H.J. Grabke started on an with active collaboration with Slovenian researchears in 1980 as continuation of the collaboration started in the late fifties by Prof. Ciril Rekar, the nestor of Slovenian metallurgy. Prof. Rekar secured for several of his researchers from the faculty and the institute, scientific training at the MPIE. After returning, the acquired knowledge and experience helped to improve Slovenian research in metallurgy and physical chemistry. With H.J. Grabke the collaboration was increased with the continuation of international conferences earlier organised jointly by the institutes MPIE, IRSID from France and the Institute of Metallurgy, now the Institute for Metals and Technology, Ljubljana. The topics of the conferences were the effects of surface-active elements present in traces in alloys (at that time residual elements) on the properties of iron alloys. He was member of organisation and scientific boards of these conferences, speaker with surveys and invited lectures on his own scientific findings as well as coauthor with Slovenian scientists of articles in Slovenian and international periodicals, as well as scientific conferences.

In those years an extensive research activity was started on the chemistry and physics of metals and alloys, which was made possible due to the development of the new analytical tecniques AES and XPS. These techniques enabled to investigate surface and grain-boundary segregations and establish the scientific explanation of physico-chemical processes occurring on the surface of metals and alloys. MPIE was one of the first research institutes to use these instruments. H.J. Grabke offered Slovenian researchers the opportunity to use these instruments; he provided fellowships and involved the Slovenian researchers in research projects of the Dept. of Physical Chemistry. In this way, Slovenian reseachers had the possibility to acquaint themselves with the newest achievements in investigations of surface segregations and their effect on recrystallisation and evolution of texture, high-temperature

Ljubljani, izvršeno na inštitutu MPIE v Düsseldorfu z uporabo najnovejših analitskih tehnik.

Prof. H. J. Grabke je vrhunski znanstvenik s področja fizikalne kemije trdnega stanja z velikim mednarodnim ugledom. Njegova odkritja so bila temelj za znanstveno interpretacijo nekaterih izkustvenih spoznanj, za termokemično in termodinamično opredelitev novih reakcij in pojavov ter za razvoj novih in izboljšanje obstoječih zlitin in postopkov. Odkril je, kako so pojavi povezani z aktivnostjo v reakciji sodelujočih elementov in spojin, ki so v kovini in atmosferi ter s temperaturo. Za pionirska odkritja, ki so temeljna za razumevanje vedenja kovin in zlitin pri različnih obremenitvah in za razvoj novih zlitin in postopkov je dobil ugledna priznanja mednarodnih znanstvenih ustanov in družb. Dela, ki obravnavajo lastne znanstvene izsledke in pregledna dela je objavil v številnih znanstvenih revijah v vseh raziskovalno pomembnih državah, tudi v Sloveniji, in v teh državah tudi predaval o svojem znanstvenem delu. Je zelo zaslužen za dvig nivoja znanstvenih raziskav na področju kemije trdnega stanja in fizike površin zlitin v Sloveniji.

Podelitev naziva častni doktor Univerze v Ljubljani prof. dr. H. J. Grabkeju je priznanje Slovenije za kakovost in izvirnost njegovega znanstvenega dela, za povezanost dosežkov tega dela z napredkom pri spoznavanju vedenja inženirskih materialov v različnih okoljih in obremenitvah, za napredek znanosti o kovinskih gradivih v Sloveniji, za dolgoletno sodelovanje in prijateljevanje s slovenskimi raziskovalci in je v čast Univerzi v Ljubljani.

Člani uredniškega odbora in sodelavci revije Materiali in tehnologije čestitamo profesorju H. J. Grabkeju za visoko priznanje in mu želimo še mnogo let uspešnega dela.

Za revijo Materiali in tehnologije

Franc Vodopivec, glavni urednik

oxidation, electrochemistry and corrosion. Thanks to H.J. Grabke, part of the experimental work for several master and doctor theses presented at the University of Ljubljana was carried out at the MPIE with modern analytical tecniques. His activity and collaboration contributed a significant degree to the quality growth of scientific research in topics related to solid metals and alloys in Slovenia, and especially to the physics and chemistry of surfaces and interfaces.

H.J. Grabke is a top-level scientist specialised in physical chemistry of solid state, with a wide international reputation. His discoveries were the basis for the scientific explanation of some earlier empirical findings; for the determination of thermodynamic and kinetic characteristics of new chemical reactions and processes as well as the improvement of industrial alloys and processes. His scientific work is mostly related to the linking of the activity of different elements present in alloys with the composition of the atmosphere and to the reaction temperature. Several prestigious international awards confirm that his achievements were appreciated also in the international scientific community.

The awarding of the title of Doctor Honoris Causa is a recognition by Slovenia for his scientific achievements which were essential for understanding the engineering behaviour alloys by great chemical and mechanical sollicitations, for the improvement of the research of solid alloys in Slovenia, for his many years of collaboration and friendship with Slovenian scientists and it is also an honor for the University of Ljubljana.

All members of the editorial board of the journal Materials and Technology are proud to have Prof. H.J. Grabke as member of the editorial board and wish him long years of successful scientific achievements.

On behalf of the Editorial board of the journal Materials and Technology

Franc Vodopivec, editor in chief