

CONTEMPORARY CERAMIC RESEARCH - A CASE STUDY

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*Mr. Chairman,
Ladies and Gentlemen,*

It is my great pleasure to be here today and to look at many faces so familiar to me. And this is especially true with Drago Kolar, the bright centre of our Kolar's Day.

When I was asked by the organisers of Kolar's Day for the title of my speech I suggested: "Drago Kolar - A Pioneer and Ambassador of Science of Ceramics". But as you can realise from the program the title is printed as "Contemporary Ceramic Research - A Case Study" since I do not know the reason for the change, I assume it is a printing error.

May it be as it is: It does not matter! I simply take as my Case Study: "Drago Kolar" a short circuit. Because it is evident that "Contemporary Ceramic Research" and Drago Kolar are synonymous.

Ladies and Gentlemen, dear Drago,

"It is an obvious privilege of age to be able to relieve worldly things of their material focus and gravity and illuminate them with the inner light of the mind, where they can be seen in a panoramic view".

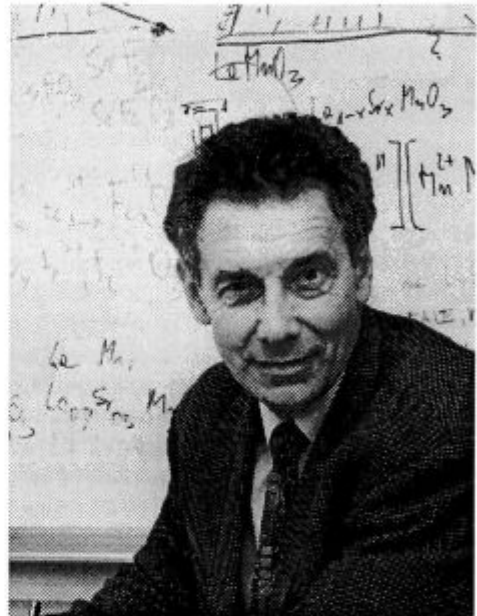
These words were written by Baron Wilhelm von Humboldt, the elder brother of the famous scholar Alexander von Humboldt as he turned sixty-five (230 years ago).

I should like to preface my laudatory remarks with these words. They convincingly impact a sense of the maturity that results from a full life, whichever turns it may have taken. Experience and calmness are expressed with these words and, if you will, an independence of spirit, a piece of self-actualisation. Humboldt's words are eminently suitable for the present occasion.

Drago Kolar has been a mover and has achieved much. This was not always accomplished at first blush and things may not always have gone according to plan. But setbacks are the spice which brings flavour to success. And in the ups and downs in Drago's life dealt by fate he has remained ever true to his own self, and that alone matters.

The inner light of his ideas - to pick up Humboldt's thought, the inner light, shines and is reflected in his actions.

Today I am honoured to report on them. I shall do so by following the chronological progress of his career, but take some liberties in the selection of events because the limitations of this programme do not permit full coverage of his remarkably multifaceted life.



Prof. dr. Drago Kolar

"Omnium eum reum..." we were taught in school. All things begin small - so also little Drago when he entered the stage of life on the fifteenth of September, 1932, that is exactly sixty-five years and fifteen days ago.

On this platform, he considered a calling in the arts or perhaps in literature - such were the career goals of the growing boy, whose broad spectrum of talents indicated a specific inclination for chemistry, but certainly none in the direction of materials science and engineering. However, it appears that Saint Barbara, the patron of the foundryman and metallurgists and more recently of materials scientists too, had an eye on him. All things begin small, but if time is used, they grow! And little Drago grew up. He went to school and he was an excellent schoolboy and then at the University of Ljubljana a very good student, who passed his final examination with great success in 1957.

Thereafter he began to work on his Ph.D. thesis. The experimental work he did at the highly respectable Jožef Stefan Institute and graduated at the University of Ljubljana. It was in 1964, when the doctor's degree of science in chemistry was confirmed upon him. This is 7 to 8 years after he has received his master certificate. 7 to 8 years are really an unusual time spent for a gradu-

ation. And at first sight one could have the impression of a lazy candidate of poor dynamic, living an unconventional life like a bohemian devoted to all kinds of fun and pleasure.

But as we know: the reverse is true! He has made optimum use of his time besides his Ph.D. activities. From 1957 to 1959 he has been a Research Assistant at the Jožef Stefan Institute. This occupation was interrupted by a one year's military service, which he has completed in the rank of a non-commissioned officer. Obviously he has not had great interest in a military career. At that time it was a must for a young and ambitious scientist to go for a research stay in a top laboratory in USA. Drago Kolar became a research participant at the International Institute for Nuclear Science and Engineering of Argonne National Laboratory, Illinois. He was in the age of 28 then and really enjoyed the stimulating atmosphere in a famous and renowned laboratory in which well experienced, well-known scientists co-operated with highly motivated young colleagues from all over the world.

Drago Kolar became involved in investigations on kinetic processes in solid materials. A topic of great fascination to him and which he took up again and again during his further research work; of course always with improved methods and on the basis of an advanced knowledge. His special interest was preferably directed to high performance ceramics which at that time became a research topic of highest actuality. Remember, it was the time of beginning of the so called ceramic fever. Today it is obvious with this work he has established himself in the elite of the Contemporary Ceramic Research.

It was in 1961, when Drago Kolar came back home to the Jožef Stefan Institute, where he then ran through a brilliant career from a Research Assistant to a Senior Research Associate and finally, already in 1965 to the Head of the new founded Ceramic Department, which under his leadership has grown up to be among the top ceramic research facilities in the world.

Beside his busy professional career he found enough time to court a lovely lady student named Majda, who he married in 1960. In 1964 - the year of his graduation - he also became father of the wonderful twins Jana and Aleš. Good timing! So, again, I would like to repeat: The guess, Drago has been a lazy Ph.D. candidate is completely disproved. Also in his spare private hours he was active and successful.

In addition he wrote during this time five papers, which have been published in recognised scientific journals. It is really remarkable!

His very first article was published 1962 in the March issue of the Journal of the American Ceramic Society, the leading Journal in the field.

In his first paper entitled: "Influence of Gas Flow on DTA curves of UO_2 ", he described the use of Differential Thermal Analysis to study the oxidation behaviour of UO_2 . The resultant conclusions he gave in regard to the oxidation kinetics are still relevant today.

Numerous other publications followed the first ones. Meanwhile more than 200 papers are on his list of publi-

cations and another more than 200 are published in proceedings, monographs and encyclopaedias. He holds 8 patents, has written two fine textbooks on ceramics and is editor of 5 Proceeding Volumes of International Conferences. To underline Dr. Kolar's great scientific potential, one should also mention the high number of invited and introductory lectures on conferences, universities and institutes abroad. I have had the pleasure to hear many of his lectures and I have always been impressed by their precision and lucidity.

Drago Kolar's first scientific actions have fallen in a prosperous time for the field of materials science, which flourished, and consequently had a strong influx of students and scientists from traditional disciplines, mainly from physics. It has been a wonderful stimulating period, full of new and exciting possibilities.

The electron microscopy, for instance, became introduced to materials investigations and brought a deeper insight into the microstructure. The metal physicists examined the structure of real crystals and established the basic understanding of the influence of structural failures on properties. With the upcoming modern computers, simulations and calculations of complex processes and multicomponent materials of higher order could be handled much easier than ever before.

In those days generous support to all fields of science was the rule but the outstanding contributions were given to nuclear research and development. Accordingly, nuclear materials have been investigated with preference. This has also influenced Drago Kolar's work. Synthesis, processing and properties of Uranium containing materials have been mainly his study objects. However, the period of nuclear euphoria was short and even changed to serious non-acceptance by many people, as we know. Many of the reactor research centres, which have had grown up very fast had to take into account the changing situation and to look for other research topics.

No doubt Drago Kolar was among those, who have easily foreseen this development. As a consequence he fixed another aim for the research activities in his department and himself. He decided for advanced materials, and more specifically for functional ceramics. $BaTiO_3$ based materials became his personal favourite - one can say "his great love". And indeed these substances are multifunctional with many facets and suitable for several applications; as disks and multilayer capacitors for instance and microwave ceramics and others. $BaTiO_3$ can really be compared with a coquettish, charming, but mysterious and sometimes even a tricky lady who never fully opens her heart. Comparable with Mona Lisa whose mysterious smile has inspired men's fantasy since long. But Drago Kolar took away many secrets from the difficult and brittle lady $BaTiO_3$ and clarified utmost complex phase relations of $BaTiO_3$ based multicomponent systems. He discovered several ternary compounds with perovskite like structures which exhibit good dielectric properties and high temperature stabilities. And he is among those who gave the most solid results in this field. With same exactness he studied the exaggerated

grain growth, twins formation, processing, and sintering of BaTiO₃ based materials with the aim of dense materials of excellent quality.

But of course, BaTiO₃ was not the only substance investigated by him. More or less all oxide - nitride and carbide based advanced ceramics have been object of his sophisticated studies. His main scientific interest was always directed to the interrelation between processing, microstructure and properties. Processing mechanism determine the microstructural formation. And the microstructure affects many technically important properties and is therefore given considerable attention in science, development and testing of materials. The higher the demands on a material, the more sophisticated the microstructural insight becomes, i.e. the more exacting the requirements on the microstructural parameters will be. "Microstructural engineering" or "microstructural design" are the key words that characterise these problems. This scientific strategy is in full accordance with the intentions of the Max-Planck Institute for Metals Research at Stuttgart. And this conformity is the basis for our long-lasting fruitful and pleasant co-operation with professor Kolar and his wonderful team. For that co-operation I would like to express my sincere thanks to you and your co-workers. And I am doing this also on behalf of the board of directors of our institute. I have to bring the greetings and the message: "Dear Drago, you are welcome in Stuttgart at any time!"

It is an extraordinary merit of Drago Kolar that he in all his scientific efforts has never lost the view for the requirements of application. Drago Kolar took a scientific curiosity and turned it into an engineering material, whose economic utilisation he significantly influenced.

Best in all these activities he never deviated from his high scientific standards.

Doubtless he belongs to those pioneers who build bridges from basic research to application, seeking close co-operation with industrial partners.

This underlines again his foresight, for today transfer of science and innovation are required more than ever before. It is a precondition for all support from governments, business and industry. Here I would like to quote some remarks of Gottfried Wilhelm Leibniz, the great philosopher and mathematician who lived three hundreds years ago. He stated in that time already: "The work of science should be application-oriented from the outset. Otherwise government will withdraw its hands for, the ministries will soon tire of useless curiosities and not recommend the prices to put much stock in them."

Teaching and research were always an inseparable unity to Drago Kolar and it is his ongoing concern that his knowledge and research skills will pass on to future generations.

Numerous diploma and doctoral candidates have contributed to his scientific work. Here, it is Drago Kolar, who must be credited for defining the problems, setting quality standards and providing critical guidance to his co-workers. Many of them are present today and will testify to his positive influence on their work.

It is indeed impressive how engaged Drago Kolar took over all the pleasure and burden of an academic teacher beside his extensive duties as head of the Ceramics Department of the Jožef Stefan Institute. Since 1972 he is teaching at the Faculty of Chemistry and Chemical Technology at the University of Ljubljana. The same place where he had done his first steps into science. What a nicely closed circle! After being assistant professor first, he became a full professor of ceramics and materials science in 1977. He thereby entered a circle of individuals of whom Johann Wolfgang Goethe stood in awe and admiration when he wrote to his father in October of 1765: You will not believe what a splendid affair a professor is: I was delighted to observe several of these fellows in their glory."

Beyond research and teaching he maintained contacts with many universities and research laboratories and succeeded in bridging research and applications in a most impressive manner. Some of this will become evident in the presentations by several of his road companions, which are to follow. In acknowledgement of his extraordinary merits in broadening the foundations of materials science and applying this knowledge to the development of advanced materials he received several honourable invitations as a guest professor or a member of advisory boards. I can not mention all of them. As an example for many others I would like to mention the Keating Crawford distinguished visiting professorship of Metallurgical Engineering and Materials Science of the University of Notre Dame, Indiana. During this period from 1982 to 1983 he had the opportunity to stay in close exchange of ideas and theories with the famous George Kuczynski, one of the bright brains in the science of sintering.

The high reputation of Drago Kolar creative power is also underlined by the many awards he has won. I have counted about 25, but would like to mention only one, which I think is the one which represents Drago Kolar's life - work best. That is the distinction as an ambassador of science of the Republic of Slovenia. And I would like to go beyond that and add: he is in addition an impressive ambassador of contemporary ceramics and of science of sintering!

Ladies and Gentlemen, there is a saying among children in our country which is often quoted: "The uncle, who brings a present is much better than the aunt, who plays the piano." And I think since I have not played the laudation piano plentifully, I have to deliver a present. It is a very special one: This sculpture is known as the "Two Particle Man" or "Sinterman". It is the highest distinction that the P/M Committee of the German Materials Society can bestow. It is only conferred for exceptional contributions to the field of sintering whereby the recipient is not only critical of his own performance, but also has a sense of humour. The Two-Particle Man consists of spherical powder particles of a particular size distribution, so that in the first sintering stage they form a neck, just as how we understand the two particle sintering theory. The body which represents the particle, and the head which embodies the theory, are equally large.

Of course, that is a big compliment to the theoreticians. Drago knows very well: Theory and practice in sintering are like the hare and the tortoise in a race. Whenever the theory - hare breathlessly reaches the next check point he finds the Practice - tortoise already there. The tortoise smiles and explains: I don't know how, but I am already here!"

This trophy, a high distinction in a humorous form, is in significance comparable to an Oscar. Up to now it has only been awarded five times to excellent scientists and practitioners in the field of sintering. And now Drago Kolar; the award of this trophy is in recognition of your extraordinary contribution in densification ceramic powders which has brought many advantages. Here symbolised by an alumina ball of full density for bioimplantation. The recognition of your theoretical contribution is symbolised by the 3 particles in your hands, which stand for the 3 particle theory, on which we already had endless discussions. May you, Drago Kolar, as the youngest prize holder, stay in freshness of your colleagues and friends of the German Powder Metallurgy Committee. And I may add, it is the desire of all of us.

Ladies and Gentlemen,

Drago Kolar is a scientist for whom mental image and practical implementation are not opposites but form a fertile contribution. This I have attempted to demonstrate with an account of his professional career.

His recognition among peers had led to his engagement in numerous extra curricular activities which he took on and continues to take on cheerfully. By the latest count there have been 16 membership in workshops, topical committees, advisory boards, executive councils, review committees, editorial boards, and others. In all of these bodies he is never just a member but an active participant in word and deed who gets noticed by his crisp language and his spirited involvement in discussions. Again, I will mention only one example, which involves all fun and trouble of the preparation and realisation in connection with committee activities. That is the Yugoslav - German co-operation on Engineering Materials Science and Technology. This co-operation started in 1972 with good financial support of German government and is now continued by bilateral Slovene-German activities. From the beginning this scientific partnership was characterised by a stimulating exchange of scientists in different fields of research. I think it is not exaggerated to claim, Drago Kolar was a main driving force behind the co-operation and pushing the realisation of the regular meetings. He was the first who has contacted us after the disintegration of former Yugoslavia to start with the Slovene-German co-operation again. In June 1992, he wrote to me: "In the meantime, we are trying here to

keep our activities on decent level. It is not easy in changing political situation. We are trying to escape the pitfalls of separation. However, the price in economical terms is high. But prospects are great and with a little help we may catch the prosperity again. My letter concerns possible co-operation ...". And now, five years after independence, Slovenia is a completely accepted candidate for the European Union.

Now, of course, Ladies and Gentlemen, no honest human being would want to stand up and praise his fellow colleague unless he can claim some affinity with him. In this sense, I had no difficulty answering in the affirmative when Prof. Stane Pejovnik asked me to present this laudation.

However, the more I dug into Drago Kolar's background the more obvious it became that I had missed a few things and that, perhaps, someone else would have been better qualified to give the talk. He might have put a different spin on events in his life and surely would have illustrated other facts than I did. What I can say is that: with the study of his life history, my admiration of Drago Kolar has grown greatly. The performance of Drago Kolar can only be explained by personal effort beyond the call of duty, a sovereign command of the scientific field and the joy of creative work. It goes without saying that one's work environment must be supportive, providing outstanding co-workers, good infrastructure and a peaceful home.

A word about Drago's hobbies: First his work on BaTiO₃, second his work on exaggerated grain growth, third condenser ceramic and then some gardening in the garden of his weekend house, bicycle riding and slow walking together with his male cat David.

Now Drago Kolar leaves his position as Head of the Ceramics Department. But he will not disappear and will be present in the department and his partners at the university and, of course, in the minds and heads of his co-workers and colleagues. And it would be wise to trust furthermore in his experience and advice.

In closing, I should like to add a personal note of friendship that brings us full circle to the words of Wilhelm von Humboldt with which I began. The words are borrowed from inscriptions in St. Paul's Cathedral at Baltimore: "Cheerful and calmly accept the council of age. Take leave of things of youth with grace. Whatever your work and your yearnings may be, maintain peace within your soul, in the noisy bustle of life".

Dear Drago, your colleagues and the present assembly thank you for your many contributions to our field. We wish you, your family and your institute the very best for a happy future.

Please accept our congratulations and best wishes on your 65th birthday.