SPOTLIGHT

on wear-resistant materials

by M.S. POWELL*

A colloquium on 'Recent Developments in Wear-resistant Materials', organized by the Technical Programme Committee: Physical Metallurgy of the SAIMM, was held at Mintek on 7th May, 1985. After delegates had been welcomed by Dr P.T. Wedepohl, Chairman of the Organizing Committee, Mr J.D. Austin, President of the SAIMM, delivered the opening address. He drew attention to the very high costs incurred in several countries by wear of various kinds, and pointed out that substantial savings could be achieved simply by the application of existing technology. He also pointed out that wear was not an intrinsic property of a material, but depended on the system as a whole. Finally, he drew attention to the stated aim of the Colloquium, which was to inform delegates of the properties, applications, and limitations of wear-resistant materials of various kinds in different environments.

Morning Session

The morning session, ably chaired by Dr J.B. Clark (C S I R), started with a keynote paper by Professor A. Ball (University of Cape Town). He gave an excellent introduction and overview 'On the Mechanisms of Wear and the Performance of Engineering Materials'. He stressed that, as design, materials, and fabrication were interdependent, they should all be linked into a co-ordinated whole. He outlined the general approach to materials selection as the assessment of service conditions, the devising of suitable testing methods, the finding and testing of materials, and the choice of a material with a view to availability and cost-effectiveness. It had been shown from the extensive testwork undertaken at the University that material hardness was not completely indicative of a material's abrasion resistance. There was a synergistic effect between abrasion and corrosion, and wear was a two-stage process in which there was an accumulation of strain followed by microfracture.

Dr J.V. Bee presented work of the Metallurgy Department at the University of the Witwatersrand on 'The Development of Abrasion–Corrosion-resistant Steels for Mining Applications'. In this work, they had defined the material properties required, such as the minimum hardness and toughness, and had then followed the route of microstructural design. This approach was laudable for its sound basis, which had paid off in successful tests on a commercially produced sample.

Professor D.D. Howat (Mintek) described the testing and development of improved 'High-chromium White Irons'. The most important factor was to reduce the formation of pearlite and bainite, both being undesirably soft, which formed during the slow cooling necessary for thick castings. An increase in the chromium content and the addition of up to 1,5 per cent molybdenum could allow a six-fold increase in casting thickness, while the addition of 5 per cent vanadium eliminated the need for high-temperature heat treatment. Mr A. Collins (Mill & Industrial Services) followed up by indicating the application of these castings, which generally covered high-abrasion and low-to-medium impact situations.

During tea the delegates studied the posters on exhibition, which illustrated the research work in wear being carried out at various institutions around the country.

Dr C. Brooks (working at the C S I R, on leave from the University of Exeter) discussed the 'Structure and Wear of Ultra-hard Materials'. Even the two hardest materials, diamond and cubic boron nitride, experienced dislocation movement at room temperature, which was extended to indentation creep at 1000°C, and could wear by diffusing into a softer material. He also described how wear investigations were being carried out by the explosive detachment of a tool from a workpiece and inspection of the chip remaining in the work surface.

In his talk on 'Alumina Ceramics', Mr D. Kotze (MOH-9) set about convincing the audience that ceramics had a far wider application than was generally realized. He presented the user's viewpoint that 'Things get smaller as you use them'. Design was of the utmost importance in minimizing the angle of attack of impinging particles, avoiding points of stress concentration, and laterally containing and soundly backing the rather brittle ceramic. Dr A. Kingon (C S I R) continued convincing everyone of the usefulness of ceramics in his study of 'High Technology Ceramics' by describing how ceramics could be toughened to show no brittleness at all. Coatings, composites of ceramics, and ceramic–metal combinations were important in extending the use of ceramics to include pump and valve parts, grinding media and mill linings, pneumatic conveying, high-temperature engineering components, and extrusion dies.

Afternoon Session

The afternoon session, chaired by Professor N.C. Joughin (Chamber of Mines Research Organization), was initiated by Mr R. Thomas (Solidur Plastics), who introduced his talk on plastics in mineral processing by stating that plastics could be tougher and more wear-resistant than steel in certain applications. The all-round champion in this field was ultra-high-molecular-weight (UHMW) with its high toughness, very low coefficient of friction, workability, lightness, and low cost per unit volume. In tests with sand and quartz slurries, UHMW had yielded substantially improved life over steel, thus lending itself to uses such as non-blocking chutes, bins, hoppers, idlers, and impellers.

Mr R. Ransom (Mill & Industrial Rubber) opened his

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address on 'The Rubber Lining of Plant and Equipment' by chastising Mr Thomas for calling the original mackintosh a plastic, when it had actually been rubber. However, upon being questioned, he admitted that the difference between modern synthetic rubbers and plastics was sometimes uncertain and actually unimportant. Rubber could absorb large quantities of energy through deformation, thus performing in a manner quite contrary to that of ceramics, which could withstand sliding wear. The many compounds making up a rubber allowed it to be designed for specific applications, such as resistance to a particular chemical.

Mr V. Statford (UTP Welding) described the variety of processes and materials used in weld surfacing, and stressed that the artisans applying the surfacing should be educated on these and their applications. Wear resistance did not depend only on overlay hardness; for example, a swing-hammer crusher was surfaced with a composite of chromium carbide and austenitic manganese steel to provide a combination of abrasion and impact resistance.

Dr A. Wells (C S I R) introduced glow-discharge-assisted surface heat treatment as the diffusion of elements into or out of a surface. A chamber was filled with the appropriate gas and a potential difference was applied between the work surface and the chamber wall. The evenness of the coating over the whole surface and the importance and applications of nitriding and boriding were discussed.

In the final paper, Dr R. Hutchings (Univesity of Cape Town) discussed ion implantation with particular reference to its effectiveness in wear-protecting precision-dimension engineering parts, tools, and dies. It was commercially available locally, but its major drawback was the difficulty in reproducibility and quality control.

In the general discussion, Professor Ball replied to a query about the difference between mode and mechanism of wear that the wear mechanism occurred within the surface to produce the observed wear mode on the surface. It was also concluded that knowledge of abrasion mechanisms in polymers was lacking, possibly because polymers had only recently come into extensive use.

In his summing up, Dr M.P. Shaw (C S I R) emphasized that, as users were the most important people, it must be ensured that the research work being carried out reached them. He congratulated the speakers on the quality of their talks and on their contributions to the understanding of the relationship between structure and properties of materials.

General

In general, the reaction of the delegates to the Colloquium was very favourable. The full spectrum of materials had been covered, and user, manufacturer, and researcher had been brought together. However, it was clear that there was inadequate education on 'alternative' engineering materials at the university and technikon level. When added to the fact that there is definitely no panacea to all wear problems, this lack of education leaves the user confused as to how to select from the variety of materials available. This Colloquium had indicated some of the available materials, but a seminar was needed on materials selection from the user's point of view.

Corrigenda to article on copper*

by D.J. Crowe†

I read with considerable interest the recent articles on copper by Mr C.O. Beale as published in the *Journal*. However, in Part II the section dealing with Prieska Copper Mines (Pty) Limited contained several factual errors, details of which are given below.

Page 109 The second sentence of the second paragraph in the section entitled 'Prieska Copper Mines (Pty) Ltd' should read: By *1971* diamond drilling had indicated the presence of about *47*Mt of ore ...

Page 110 **Underground Mining.** 'Mining started in 1974' should read *Mining started in 1972 and full-scale operation was achieved in 1974.*

Second paragraph. 'Ore is blasted from holes drilled parallel to the orebody from stripping crosscuts' should read *Ore is blasted from rings of near-vertical fan holes and sliped to the full width of the stripping crosscuts.*

Page 110 **Concentration,** last paragraph. The concentrates are thickened ... and are then transported ... to *Port Elizabeth* (not Saldanha Bay) for export.

Page 110 **Current Situation,** second sentence. 'The Company now judges that ore below the 957 m level' should read *In 1982 the Company concluded that ore below the 957 m level ...*

Page 111 **Current Situation.** To update the article to the present situation, a sentence reading as follows should be added after the concluding sentence: *However, in February 1985 the Company announced that production was expected to continue until around mid-1986, primarily as a result of the significant increase in rand prices for copper and zinc, which had permitted the profitable reclamation of substantial tonnages of lower-grade ore accumulations contained in old stoping areas.*

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