A personal tribute to Dr. Šalak

Powder metallurgy is in principle a process in which metallic particles consolidate to form a more or less porous body by a solid-state treatment, which is commonly called sintering. The powder is usually pre-compacted. The first attempt to characterize the sintering process was made by Professor G. Kuczynski as early as 1949; Kuzcynski proposed a very simple model of two adhering spheres, and analyzed the kinetics of the growth of a neck starting from the point of contact. He assumed 4 different possible mechanisms, all leading to the growth of the neck: plastic flow, surface diffusion, bulk diffusion and a possible transfer of matter via the gas phase. He analyzed these processes and came up with equations, which gave different exponents to the term a (length of the neck) as a function of time t upon isothermal heating - sintering.

Kuzcynski's equations were re-analyzed and re-considered by innumerable scientists since then, amended by many, yet they have become a "classic" in the incipient era of the science of sintering.

The last mechanism was actually re-vitalized when liquid phase sintering appeared; the improbable mechanism of transfer via the gas phase became real when gas was substituted by liquid, in which the solid metal was partly soluble.

In 1979, my dear friend Andrej Šalak, DrSc., showed me micrographs, proving definite alloying of steel compacts by manganese, admixed to the iron powder. The mechanism seemed curious for many reasons, the foremost being that manganese should oxidize in the process, as the oxygen potential of the sintering atmosphere was considerably higher than that required by the Ellingham diagram (with the manganese line present).

Yet Šalak found an explanation of the documented phenomenon. Manganese possesses a curious physical property, almost an anomaly: it has a high vapour pressure, although its melting point is above 1200°C. At a temperature of 1100°C, the vapour pressure of manganese is as high as 25 Pa, close to that of low-melting metals like lead or indium. This ensures not only the transfer of the element via the gas phase, but it also ensures protection against oxidation, as the concentration of gaseous manganese in the pores of a compact far exceeds the amount which can react with the atmosphere's oxygen! The concept of "auto - protection" has become a reality in the practical sintering of a compact of iron powder, to which manganese or ferromanganese powder was added.

Much of Šalak's subsequent work has been devoted to further applied research, and his many published papers on this topic constitute established knowledge, recognized world wide.

Naturally, his scientific achievements cover other topics and areas of powder metallurgy as well, but I myself will never forget the excitement which I felt when the discovery was disclosed to me by the author, and I have also enjoyed very much subsequently carrying out some experiments, which confirmed the validity of Šalak's discovery, and its potential application in practical powder metallurgy processes.

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