Journal of Alloys and Compounds 577S (2013) S13–S17

Contents lists available at ScienceDirect

Journal of Alloys and Compounds

journal homepage: www.elsevier.com/locate/jallcom

Contribution of the academician V.D. Sadovsky to studies of martensite transformation

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ARTICLE INFO

Article history:
Received 23 August 2011
Accepted 14 November 2011
Available online 20 November 2011

Keywords:
Scientific biography
Austenite transformation
Structure heredity
Magnetic field effect
Martensite transformation

ABSTRACT

V.D. Sadovsky was born on the August 6, 1908. In 1930 he graduated from the Kazan' University and came to work at the Zlatoust machine tool plant, where he started his scientific activity. Already in his first research works he studied the effect of regimes of heat treatment on the onset temperature for the martensite transformation (M_s point) upon quenching of alloyed steels and on the amount of residual austenite.

Since 1935 to 1991 V.D. Sadovsky had worked in the department of material science of the Institute of Metal Physics, Russian Academy of Sciences. There he continued his activity related to studying the martensite transformation of austenite and effect of alloying elements on the martensite point and amount of the residual austenite, as well as on mechanical properties.

In 1950 he published his review "Transformation of austenite in martensite". Then, a series of works devoted to the influence of plastic deformation on the development of martensite transformation were issued. At the same time, there was discovered and studied a new kind of treatment – thermomechanical treatment, which essentially increased strength and impact toughness of steels quenched to martensite.

In 1961 he discovered the effect of magnetic field on the martensite transformation and in 1964, in collaboration with M.A. Krivoglaz he suggested a theory explaining this phenomenon. Later on accelerating effect of magnetic field was detected for bainite and pearlite transformations as well. These results were summarized in the monograph "Quenching of steels in magnetic field" in 1977.

In 1976 V.D. Sadovsky took part in the conference devoted to the 50th anniversary of the G.V. Kurdyumov's work that set up ICOMAT, which was held in Japan. The last visit to Japan was dated 1986 in connection with the work of the ICOMAT-86 conference.

1. Beginning remarks

The term "metallurgy" includes several technological operations: metal extraction from ores, solutions or electrolytes, casting, forging, milling and heat treatment as a final process. All life of Academician Vissarion Dmitrievitch Sadovsky was devoted just to the scientific foundation of heat treatment, i.e. to physical metallurgy (Metalkunde in German). He was one of pioneers in establishing diagrams for undercooled austenite transformations (TTT-diagrams) in alloyed steels so he published in 1947 the "Atlas of transformation diagrams" which was the first in the USSR and one of the earliest in the world [1]. Together with followers and colleagues he discovered the phenomenon of the structure heredity during heating of steel [2,3], proposed the method of high temperature thermo-mechanical treatment and presented verifications for it [4]. This thermo-mechanical treatment results in strengthening of steels and prevents the brittle fraction of steel parts. V.D. Sadovsky made the exceptional contribution to the problem of the magnetic field influence on martensite transformation in steel [5,6].

V.D. Sadovsky was an exigent scientific supervisor, excellent tutor and deeply decent man. His numerous pupils form a backbone of the Ural scientific school of metal scientists. All scientific biography of Sadovsky reflects a whole process of the generation and advance of this school which in turn determined the general level of metal science in the former USSR and modern Russia. Ural scientific school of metal science was initiated on the basis of Ural industry in twenties of the former century, Ural scientists made a great contribution in the defense of our country during the World War II. After war Ural school expanded significantly. Due to activity of Sadovsky and his pupils the influence of Sadovsky ideas is

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doi:10.1016/j.jallcom.2011.11.067

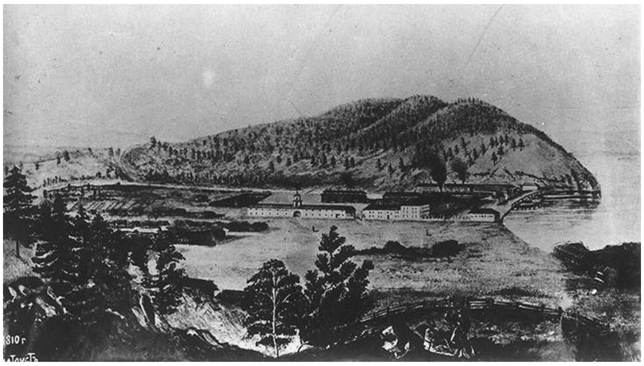

Fig. 1. View of the Zlatoust tool plant in the 19th century.

spreading far beyond Ural over whole territory of the former USSR and abroad.

2. Sadovsky scientific history

V.D. Sadovsky was born on the August 6, 1908, in the Omsk city (West Siberia). He graduated from Department of Physics and Mathematics, Kazan University in 1930 (his diploma was in alloys chemistry). In the same year he was appointed to metallography laboratory of the Zlatoust tool plant (Zlatoust is the city at the South Ural, in Russian Zlatoust means "The Golden Mouth", i.e. an eloquent person. This is a Russian name of the Christian Saint Ιωάννηζ ο Χρυσόστομοζ). The Zlatoust tool plant was founded in 1754; the first blast furnace has been fired here in 1761. Since the beginning of XIX century Zlatoust plant became a center of mining area of South Ural, since 1815 the fabric of cold steel arms (weapons) has been opened (Fig. 1). Metal science has been started in the Zlatoust tool plant: an optical microscopy has been applied here for the first time in 1831 to observe the structure of damask steel by Paul Anosov (the result has been published in 1841). So the affiliation to Zlatoust plant was a good start for Sadovsky as a metal scientist (Fig. 2). In the next 1931 year he published his first article entitled "Quenching of steel and steel parts with minimal dimensions changes" [7]. The last public talk entitled "Correction of the coarse grained structure during heat treatment of steel (once more about Chernov "*b*" point) Sadovsky gave at the 7th International l Congress on heat treatment of materials in Moscow, December 1990 [8]. He passed away on 17 February 1991. His bibliography list contains 428 items including 10 monographs. While analyzing that list one can delineate several scientific problems in which there is a significant contribution made by him:

1. Transformations of undercooled austenite.
2. Tempering brittleness of steel and fracture surface.

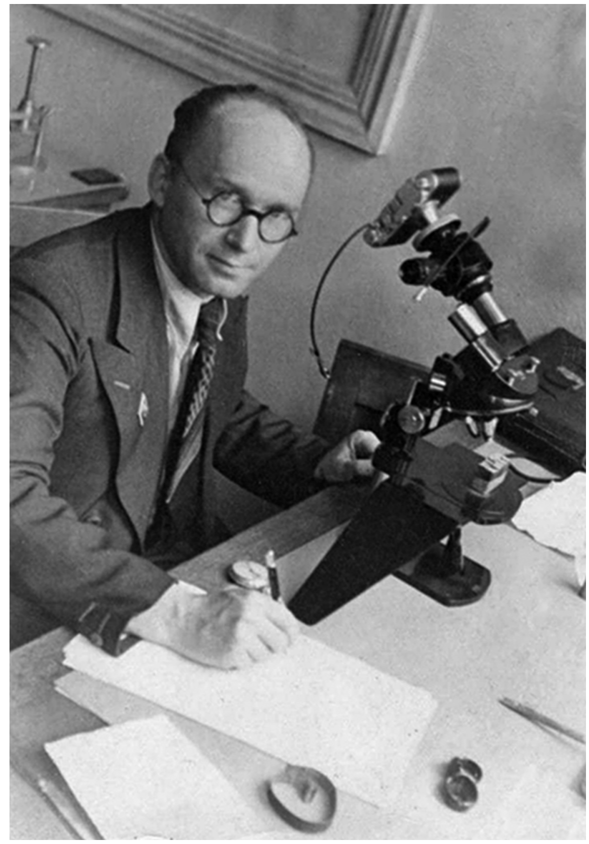

Fig. 2. V.D. Sadovsky in the laboratory of the Zlatoust plant, 1930–1935.

3. High temperature thermo-mechanical treatment.
4. Structure heredity during heating of steel.
5. Martensite and bainite transformations. Retained austenite.
6. Martensite transformations in magnetic field.

It must be noted that at the time of Sadovsky arrival the Zlatoust tool plant was one of 2–3 USSR plants where alloyed steel can be produced. An austenite decomposition kinetics, as has been shown later, is significantly distinct from decomposition kinetics in plain carbon steels. As Sadovsky remembered by himself his first paper was fulfilled and written mainly under the influence of paper by D. Lewis entitled "Transformation of Austenite into Martensite in a 0.8%C carbon Steel" [9], and this paper had a strong influence on the development of metal science in our country. During all his life Sadovsky kept this interest to the problem of retained austenite which has been appeared just at this time. On 1935 he was invited to Metal Science Laboratory of the Ural Branch of Academy of Science

Fig. 3. Microstructure of the 0.37%C–3%Ni–Cr steel after gradient heating by electric current. The thickness of the wedge shaped specimen decreases from left to right (specimen total length is about 40 mm), grain size refinement (right end) corresponds to the largest heating temperature [11].