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Heat resistant engineering materials for industrial application

A number of new generation materials such as non-ferrous and ferrous-alloys, superalloys, steels, ceramics, polymers, composites, etc., designated for service in the extreme environments have been developed. Some of this materials provide the protection/insulation from heat (e.g. ceramics, polymers) and some offer an outstanding high temperature mechanical properties for the demanding aerospace, energy and manufacturing industries where the service condition often includes mechanical load, thermal shock, vibrations and oxidation/corrosion in temperature much above 1000°C. Most industries still rely on ferrous and nonferrous alloys as the main engineering materials for a high temperature application because of its unique combination of strength, creep resistance, resistance to oxidation/chemical attack and a good thermal conductivity during service. Moreover, the availability and price of most heat resistant steels and alloys make them a preferred industrial material for a high temperature application. A metallurgical study of a wide variety of manufacturing components made of a Fe-, Ni-, and Co-base heat resistant alloys has been performed in the past years. The structural changes due to a long exposure to service temperature >1000°C, heavy load, vibration and thermal stress have been carefully analyzed. In general, most of heat resistant steels and alloys deteriorate (and eventually fail) during service due to unfavorable microstructure changes such as: Decomposition of carbides or other "reinforcing" phases, precipitation of the detrimental phases, phases coalescence and growth, dendrites recrystallization, oxidation and chemical attack on grain boundaries and the alloy depletion in Cr. It was also found that the microstructural changes are associated with not fully recognized changes of a certain physical properties, mainly magnetic, of the alloy. Since the microstructural and magnetic changes are proportional, using the magnetism to evaluate the current metallurgical condition of the heat resistant equipment parts is very promising.

Biography

Zofia Niemczura is a Metallurgical Engineer granted with PhD and DSc degrees in Physical Metallurgy from Technical University, Poznan, PL, and from Academy of Mining and Metallurgy (AGH), Krakow, Pl. As a Professor at TU Poznan, she was focused on microstructure-property relationship, phase transformation in steels, heat resistant alloys and failure analysis, which resulted in 36 publications and 2 books. She worked later as a Researcher and Visiting Professor in University of IL at Chicago and ultimately accepted a Researcher Position in Arcelor Mittal LLC Global R&D, East Chicago, USA. Her main technical focus in recent years was: Heat resistant alloy deterioration mechanism and prevention, tool steel, alloy selection and evaluation, failure analysis of manufacturing equipment and defects in steel sheets. She has been granted two USA patents and has published student textbook on Mechanical Metallurgy for UIC students plus several additional papers in the journals and conference proceedings. She is also recipient of various recognitions during her carrier in Poland and in USA.

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