

# Preface

The high-chromium (9–12 wt%) ferritic/martensitic steels were developed during the first half of the last century and have a long history of use in the power-generation industry as boiler and turbine materials as well as for other applications. The original steels were based on 12% Cr and 9 and 12% Cr-Mo compositions, but the need for reduced generating costs in power plants (higher efficiencies, which means higher temperatures) has resulted in the development of more highly alloyed steels with progressively enhanced creep-rupture strengths. These developments have allowed the maximum operating temperatures in the boilers to be increased from less than 450 to 620°C and the  $10^5$  h creep-rupture strengths to be raised from around 40 to 140 MPa. Advanced steels of this type are now being developed with a target operating temperature of 650°C and a  $10^5$  h creep-rupture strength of 180 MPa.

High-chromium Cr-Mo steels were selected for use in steam generators of nuclear power plants during the 1960s, and steels with additions of V, Nb, and/or W and with oxide dispersions were subsequently chosen and evaluated as fuel element core component (ducts and cladding) materials in sodium-cooled fast breeder reactors. Since the late 1970s, the steels have also been considered as potential first wall and breeding blanket structural materials in fusion reactor systems. The fission (in-core) and fusion reactor applications require steels that are resistant to radiation damage induced by bombardment from high-energy neutrons as well as to retain adequate toughness and elevated-temperature strength during service. The requirement for safe and routine operation and decommissioning of a fusion plant and the disposal of radioactive wastes has also demanded the development of steels with enhanced radioactive decay characteristics. This development of “reduced-activation” steels, containing W, V, Mn, Ta, and Ti and without Mo, Nb, Ni, and other radiologically undesirable elements and possessing an appropriate combination of the other desirable properties, is still progressing.

This monograph presents a detailed review of the development of the high-chromium ferritic/martensitic steels for exposure to the high-energy neutron environment of a fission or fusion reactor, and the book should be of most interest for people involved in the use of the steels for nuclear applications. However, to provide a baseline for understanding the irradiation effects on the steels, it is first necessary to understand the basic properties of the steels under nonnuclear conditions. Therefore, many of the chapters are devoted to such considerations, and it is hoped that this information will be of interest to readers beyond those involved in nuclear applications.