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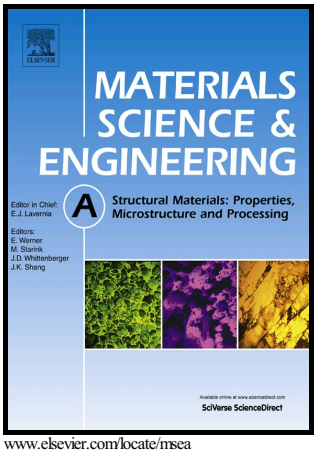


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# Evolution of nano-size precipitates during tempering of 9Cr-1Mo-1W-V-Nb steel and their influence on mechanical properties

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**Abstract**

The aim of the characterization of P911 steel is to determine the consequence of different tempering temperature on nano-size particle evolution and their effect on the mechanical properties. P911 steel was normalized at 1040 $^{o}$C for 1 h and subjected to varying tempering condition in the range of 720 $^{o}$C-800 $^{o}$C for 2 h of tempering time. To study the effect of tempering temperature on nano-size particle distribution and grain size of P911 steel, field-emission scanning electron microscope (FESEM) and optical microscope (OM) were utilized. The other tests were hardness measurement and room-temperature tensile testing was performed to characterize the P911 steel for different tempering condition. The ultimate tensile strength (UTS) and hardness have found a great dependency on the area fraction of precipitates present in the microstructure. The UTS and hardness were observed to be increased continuously with increase in tempering temperature in range of 720-800 $^{o}$C.

**Keywords:** Nano-size precipitates; tempering temperature; P911 steel; micro-hardness

## 1. Introduction

To fulfill the requirements of strength, creep and corrosion resistance, several new 9-12% Cr creep strength enhanced ferritic (CSEF) steels were developed [1–3]. In present days, environment protection from the exhaust of nuclear power plants led to requirement of high efficiency power plants operating at temperature in range of 600-650 $^{o}$C and pressure of 220-300 bar [4–6]. In recent years, several CSEF steels such as E911, P92 and P91 are used in nuclear