# Magnetic control for high chromium steel creep

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## ELyT Global
## Theme: Electromagnetic NDT
## Scientific topic: Electromagnetic instrumentation


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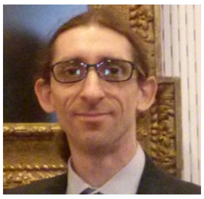
|  | **Gael Sebald**<br>[1]ELyTMaX UMI 3757, CNRS-Université de Lyon-Tohoku University International Joint Unit, Tohoku University, Sendai, Japan |  | **Tetsuya Uchimoto**<br>[1]ELyTMaX UMI 3757, CNRS-Université de Lyon-Tohoku University International Joint Unit, Tohoku University, Sendai, Japan<br>[2]Institute for Fluid Science, Tohoku University, Sendai, Japan |
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## Abstract

Creep phenomenon is an important feature to assess in high temperature applications, although the correlations with microstructure and magnetic behaviour remain unclear. In this project, 12%Cr-Mo-W-V creep test samples (used in thermal power plants) are investigated using three electromagnetic inspection techniques. Magnetic parameters based on the results are then evaluated in comparison to the microstructure. Additionally, a modified Jiles-Atherton model has been used to numerically reproduce experimental results from Magnetic Incremental Permeability (MIP), Magnetic Barkhausen Noise (MBN) and standard B(H) measurements. All the three techniques exhibit different responses in understanding creep and the modelling parameters derived from the adapted Jiles-Atherton Model parameters are then correlated to the microstructure information. Coupling between the stress and magnetic field is the main and important feature of the ferromagnetic materials consisting of various small magnetic domains in its microstructure [1][2]. Conventional Eddy current testing has been extensively used for the ferromagnetic materials characterization but when it comes to creep damage detection, it becomes difficult to distinguish between the changes caused by the actual creep damage and from the signals generated by other sources like, cracks, surface roughness, hardness etc. In this research three different electromagnetic techniques are

applied to the 12 different samples from three different categories with different temperature and stress treatments. Magnetic Incremental Permeability (MIP) is used to investigate samples as it is highly sensitive to stress. On the other hand, Magnetic Barkhausen Noise being sensitive to the mechanical changes in the materials, is also used to analyse the samples in addition to standard B(H) curve measurements. Finally, ferromagnetic hysteresis models such as dry friction quasi static model [3], Preisach model [4], Jiles-Atherton model [5], which are based on magnetic induction B versus applied magnetic field strength H, are tested to get the simulated data based on experiments. Having a physical interpretation, the J-A model [6] is chosen but it is modified to derive modelling parameters which are then evaluated against the microstructure of the test samples. Finally, experimental data obtained using different techniques applied to creep samples are presented, and the relevant ferromagnetic model is given. Fig. 1(a) below shows evolution of one of the J-A parameters 'K' vs. Precipitation number for differently treated samples. It is quite evident that the energy required (K) to break the pinning site is larger in case of higher number of precipitates.

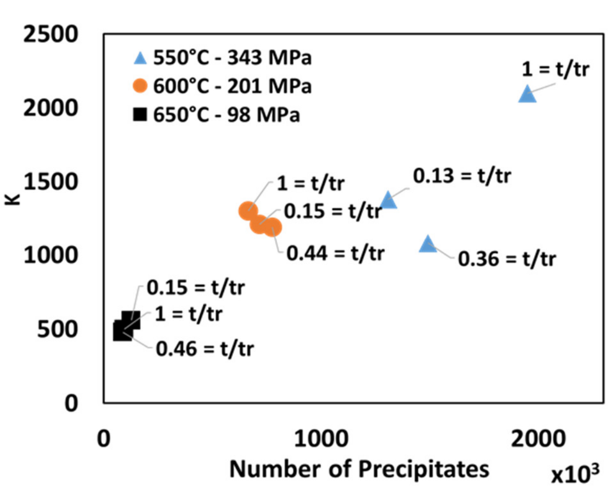


Figure 1(a): Evolution of J-A parameter 'K' vs. Precipitations

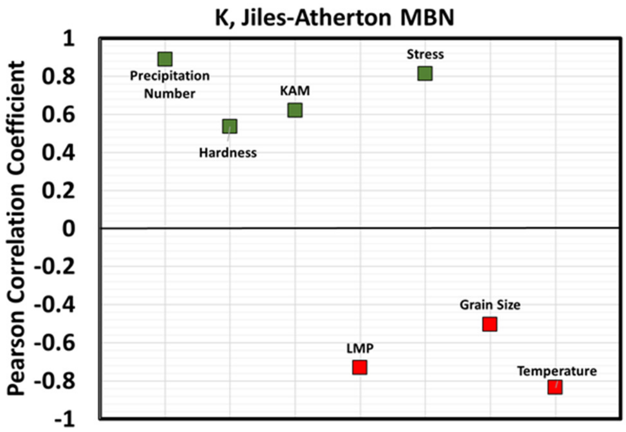


Figure 1(b): Pearson correlation coefficient for evolution of 'K' vs. different microstructural and mechanical parameters

After the determination of these parameters, Pearson correlation coefficient is evaluated against different mechanical and microstructural parameters as shown in Fig. 1(b).

## References


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