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Validation of the production of ODS alloys by extended x-ray absorption fine structure (EXAFS)

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The aim of this work is the investigation on the transformation of Yttrium during the production process of ODS alloys. The dissolution during mechanical alloying and the re-precipitation during annealing treamtments are studied by extended x-ray absorption fine-structure (EXAFS) and x-ray near-edge-spectroscopy (XANES).

Production

Fe13Cr1W0.3Ti

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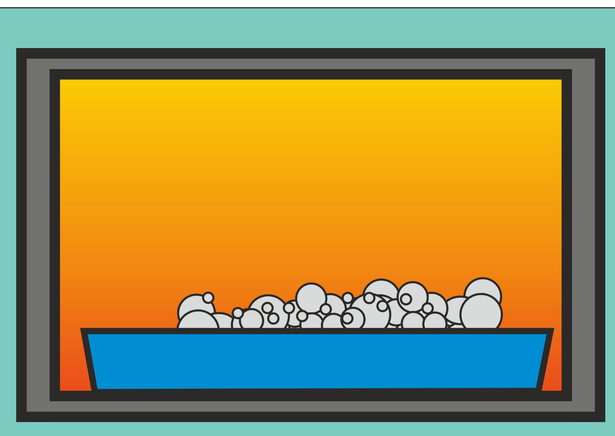
Y_2O_3

mechanical alloying

Annealing of the powders



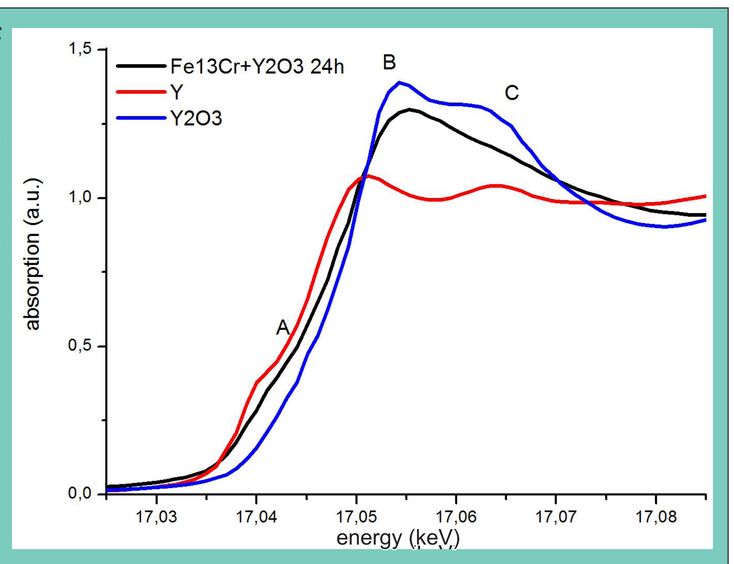
800°C / 1000°C / 1100°C

Preparation

1. Mechanical alloying of pre-alloyed (ferritic) steel powder with Y_2O_3.
2. Annealing of the powders in a vacuum furnace at 800°C, 1000°C and 1100°C for 2 hours
3. Y-K edge (17.038 keV) was used for all experiments at ESRF in Grenoble
4. Powder pellets were pressed for EXAFS measurements (in Fluorescence Mode)
5. Pure Y-foil and Y_2O_3 powder were used as reference samples (measured in Transmission Mode)

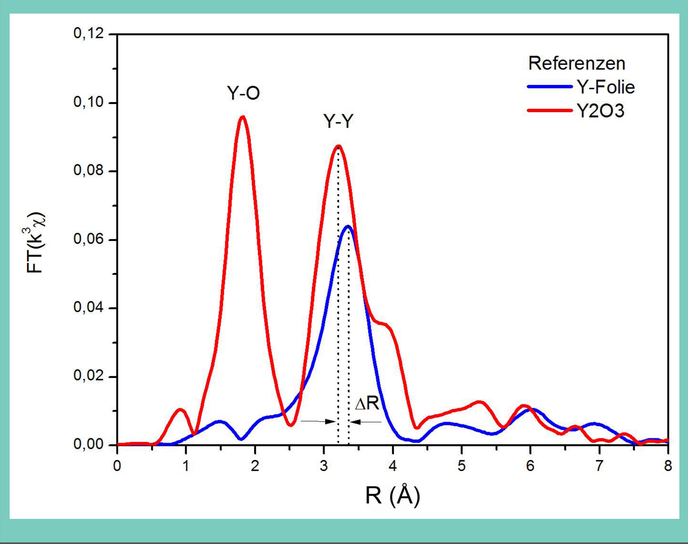
EXAFS / XANES Experiments

Mechanical alloying of the powders with Y_2O_3 causes a shift of the XANES spectrum.
The curve does not match the Y_2O_3-reference anymore.
The shift can be correlated with the dissolution of yttrium during the mechanical alloying process.



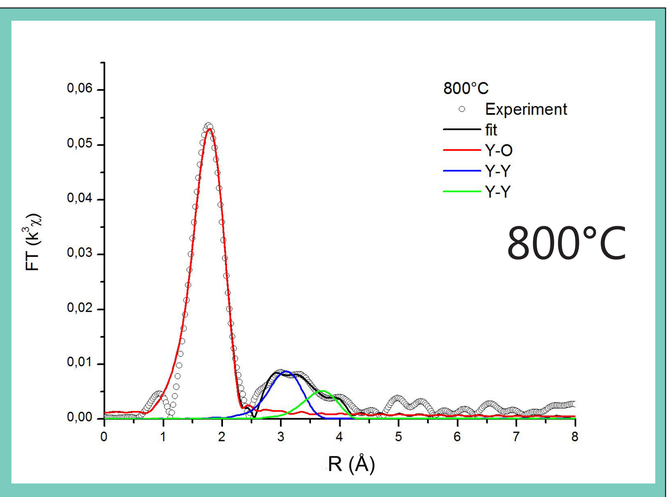
The linear combination fit of the experimental data with the two reference spectra can be used to calculate the ratio of dissolved Yttrium in the matrix:

Specimen	24h as-milled	800°C annealed	1000°C annealed	1100°C annealed
$Y_{dissolved}$ (%)	13.7	99.9	97.6	0

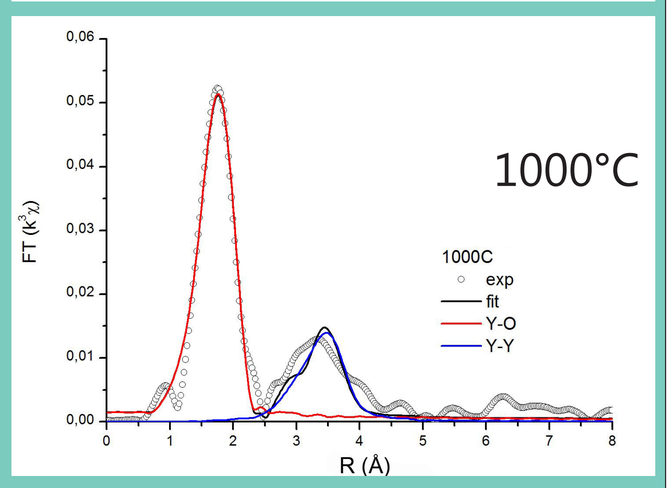


The difference ΔR for the Y-Y neighbor in Y_2O_3 and pure Y can be used to distinguish between the oxidized and pure (metallic) state of Yttrium.

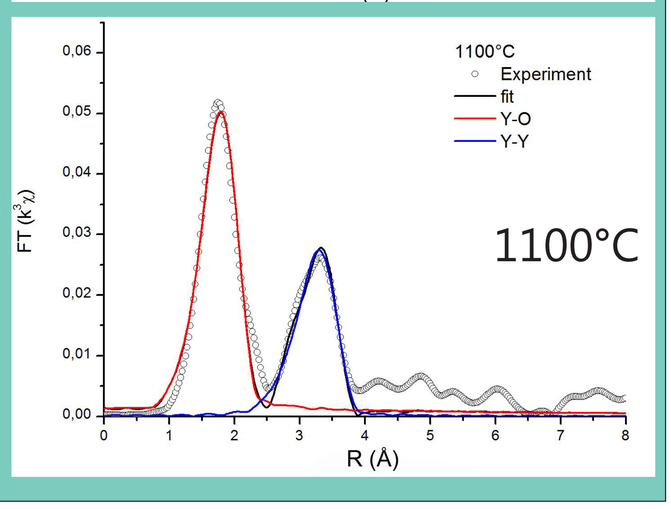
The precipitation of oxide-clusters takes place at high temperatures. Only **minor differences** can be observed after annealing at 800°C



The height for the Y-O coordination shell increased after annealing at 1000°C. **Precipitation of the oxide-clusters has occured**.



The precipitation is finished. A **full peak height** matching the Y-O coordination state in Y-Ti-O clusters can be observed.



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