Data Article

Data regarding the influence of Al, Ti, and C additions to as-cast Al$_{0.6}$CoCrFeNi compositionally complex alloys on microstructures and mechanical properties

Alex Asabre $^a$, * Janine Pfetzing-Micklich $^b$, Oleg Stryzhybora $^c$, Aleksander Kostka $^b$, Ulrike Hecht $^c$, Guillaume Laplanche $^a$

$^a$ Institut für Werkstoffe, Ruhr-Universität Bochum, Universitätsstr. 150, 44801 Bochum, Germany
$^b$ Zentrum für Grenzflächendominierte Höchstleistungswerkstoffe (ZGH), Ruhr-University Bochum, Universitätsstr. 150, 44801 Bochum, Germany
$^c$ ACCESS e.V., Intzestraße 5, D-52072 Aachen, Germany

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ABSTRACT

This brief paper contains raw data of X-ray diffraction (XRD) measurements, microstructural characterization, chemical compositions, and mechanical properties describing the influence of Al, Ti, and C on as-cast Al$_{0.6}$CoCrFeNi compositionally complex alloys (CCAs). The presented data are related to the research article in reference [1] and therefore this article can be referred to as for the interpretation of the data. X-ray diffraction data presented in this paper are measurements of 2θ versus intensities for each studied alloy. A Table lists the obtained lattice parameters of each identified phase determined by Rietveld analysis. Microstructural-characterization data reported here include backscattered electron (BSE) micrographs taken at different magnifications in a scanning electron microscope (SEM) of Widmanstätten and dendritic microstructures and microstructural parameters such as phase volume fractions, thickness of face-centered cubic (FCC) plates, and prior grain sizes. The compositions of the identified individual phases determined by energy-dispersive X-ray spectroscopy (EDX) in the transmission electron microscope (TEM) are listed as well.

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* Corresponding author.
E-mail address: alex.asabre@rub.de (A. Asabre).
Finally, mechanical data including engineering stress-strain curves obtained at different temperatures (room temperature, 400 °C, and 700 °C) for all CCAs are reported.

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### 1. Data

The XRD data present in this paper are 2θ versus intensity data obtained from our diffractometer for all investigated alloys. The XRD data are provided as Excel files (see Zip file) and a summary of the plotted diffraction patterns is shown in Fig. B2 of supplementary material of Ref. [1]. The calculated
lattice parameters together with their standard deviation for each detected phase are listed in Table 1 for all investigated alloys. BSE micrographs taken at different magnifications are presented to document the effect of micro-alloying on microstructure (see Zip file). For all CCAs, five BSE micrographs are provided, one low-magnification image with a remnant indent spanning all phases present in the alloy and four other high-magnification micrographs. From some of these BSE images, the microstructural parameters, i.e. mean prior grain size (\(d\)) and average thickness of FCC plates (\(l\)) listed in Table 2, were determined. In addition, the surface area fractions of TiC-particles listed in Table 3 were obtained from BSE images using an image analysis software (ImageJ). The local chemical compositions of the phases measured at three different locations in a transmission electron microscope for the Ti\(_3\)C\(_{0.25}\) CCA are given in Table 4. The mean volume fraction of the FCC phase provided in Table 2 were determined based on these TEM-EDX measurements in combination with a mass balance, see section D of supplementary material of Ref. [1]. The raw tensile data obtained at different temperatures are provided as Excel files (see supplementary Zip file). These Excel files are labeled as follows: alloy name, temperature at which the test was performed, test number (for reproducibility) and whether this test was presented in a figure of the related article [1]. For example, “Tensile Test\_Al\(_{13}\)-400°C-1st_selected” means that a “Tensile test” was performed for the alloy named “Al\(_{13}\)” at a temperature of “400 °C”. “1st” means that this dataset corresponds to the first tensile test performed for this alloy and “selected” indicates that this data was presented in the related article [1]. Note that even though only one test per alloy and temperature was presented in the related paper [1], both tests performed for each alloy and temperature, i.e. “selected” or “Not selected” tests were considered to assess the reproducibility of the tensile tests. In each Excel sheet, the name of the alloy is provided together with the height, gauge diameter, and gauge length of the tensile specimen. The time, force acting on the specimen, and cross-head displacement are given in the first three columns of the Excel sheets while engineering stress, strain, deformation and stress relaxation.

Table 1
Lattice parameters and standard deviations of the identified face-centered cubic (FCC) and body-centered cubic (BCC) phases for all investigated drop cast CCAs.

| Names | Nominal composition in at.% | \(a\FCC\) (nm) | Stdev (\(a\FCC\)) (nm) | \(a\BCC\) (nm) | Stdev (\(a\BCC\)) (nm) |
|-------|-----------------------------|-----------------|------------------------|-----------------|------------------------|
| Al\(_{13}\) | Al\(_{13.00}\)Co\(_{21.74}\)Cr\(_{21.74}\)Fe\(_{21.74}\)Ni\(_{21.74}\) | 0.3602 | 2E-4 | 0.2884 | 2E-4 |
| C\(_{0.25}\) | Al\(_{13.00}\)Co\(_{21.69}\)Cr\(_{21.69}\)Fe\(_{21.69}\)Ni\(_{21.69}\)C\(_{0.25}\) | 0.3616 | 2E-4 | 0.2886 | 2E-4 |
| Al\(_{16}\) | Al\(_{16.00}\)Co\(_{21.00}\)Cr\(_{21.00}\)Fe\(_{21.00}\)Ni\(_{21.00}\) | 0.3601 | 2E-4 | 0.2879 | 2E-4 |
| Ti\(_{3}\) | Al\(_{13.00}\)Co\(_{21.00}\)Cr\(_{21.00}\)Fe\(_{21.00}\)Ni\(_{21.00}\)Ti\(_{3}\) | 0.3605 | 2E-4 | 0.2889 | 2E-4 |
| Ti\(_{3}\)C\(_{0.25}\) | Al\(_{13.00}\)Co\(_{20.94}\)Cr\(_{20.94}\)Fe\(_{20.94}\)Ni\(_{20.94}\)Ti\(_{3}\)C\(_{0.25}\) | 0.3603 | 2E-4 | 0.2890 | 2E-4 |

Table 2
Microstructure parameters: mean prior grain size (\(d\)), average FCC volume fraction and mean thickness of FCC plate (\(l\)) of all studied alloys. Mean deviation for these parameters is \(\pm 5\%\).

| Names | Nominal composition in at.% | Prior grain size, \(d\) (\(\mu\)m) | FCC vol. fraction (%) | FCC plate thickness, \(l\) (\(\mu\)m) |
|-------|-----------------------------|-------------------------------|---------------------|---------------------|
| Al\(_{13}\) | Al\(_{13.00}\)Co\(_{21.74}\)Cr\(_{21.74}\)Fe\(_{21.74}\)Ni\(_{21.74}\) | 108 | 65 | 1.33 |
| C\(_{0.25}\) | Al\(_{13.00}\)Co\(_{21.69}\)Cr\(_{21.69}\)Fe\(_{21.69}\)Ni\(_{21.69}\)C\(_{0.25}\) | – | 82 | 14.00 |
| Al\(_{16}\) | Al\(_{16.00}\)Co\(_{21.00}\)Cr\(_{21.00}\)Fe\(_{21.00}\)Ni\(_{21.00}\) | >300 | 45 | 0.39 |
| Ti\(_{3}\) | Al\(_{13.00}\)Co\(_{21.00}\)Cr\(_{21.00}\)Fe\(_{21.00}\)Ni\(_{21.00}\)Ti\(_{3}\) | 55 | 55 | 0.47 |
| Ti\(_{3}\)C\(_{0.25}\) | Al\(_{13.00}\)Co\(_{20.94}\)Cr\(_{20.94}\)Fe\(_{20.94}\)Ni\(_{20.94}\)Ti\(_{3}\)C\(_{0.25}\) | 42 | 51 | 0.43 |

Table 3
Surface area fractions of TiC-particles in the CCAs with Ti + C additions.

| Names | TiC surface area fraction % |
|-------|----------------------------|
| Al\(_{13}\) | – |
| Ti\(_{3}\)C\(_{0.25}\) | 0.5 |
| Ti\(_{3}\)C\(_{0.5}\) | 1.25 |
engineering strain, and engineering plastic strain are provided in the fourth, fifth, and sixth columns, respectively.

2. Experimental design, materials, and methods

XRD diffraction pattern for all investigated CCAs were acquired using a diffractometer of type PANalytical X’Pert Pro MRD operating with a Cu-Kα radiation source (λ = 1.54 Å). The diffraction patterns were measured within a 2θ-range of 20° and 120°, a step size of 0.006° and an integration time of 280 s. The lattice parameter of the indexed phases listed in Table 1 were determined by Rietveld analysis using the MAUD program. The backscattered electron (BSE) images were taken using a Quanta FEI 650 scanning electron microscope (SEM) with an accelerating voltage of 20 kV and a working distance between ~5 and 10 mm, for more details see Ref. [2]. The mean prior grain size (d) in Table 2 was determined using the Heyn linear intercept method outlined in ASTM E−112, see Ref. [3] for a detailed description of its application. The mean thickness of the FCC plates (l) was measured using Imagic ims client software. In this software, several lines were drawn perpendicular to the plates to determine its average thickness. The average volume fraction of individual phases listed in Table 2 was determined using a mass balance presented in section D of the supplementary material of Ref. [1]. The evolution of TiC-particles in the CCAs listed in Table 3 were obtained using an image analysis software “ImageJ” 1.51k. The ImageJ software was used to collect binary images from which the surface area fractions were determined, for more details see Ref. [4]. The average chemical compositions of the phases given in Table 4 were determined using energy dispersive spectroscopy (EDX) in an FEI Tecnai F20 C² S-Twin TEM.

Tensile tests were performed in a Zwick Roell XForce Z100 machine at three different temperatures: room temperature (RT), 400 °C, and 700 °C using a strain rate of 10−3 s−1, for more details see Ref. [5].

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.104742.

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