Structural characterization of Al-Ni-Pd system using High Resolution Powder Diffraction (HRPD)

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Aluminium based alloys are most often used for technological applications as structural components in engineering industry inclusive of automotive, aerospace and construction industries due to low specific weight, excellent corrosion resistance, high strength and stiffness to weight ratio, good formability, high electrical and heat conductivity [1]. The demand for materials that are strong, stiff and ductile at high temperatures caused increasing interest in intermetallic aluminium alloys such as Al-Ti, Al-Ni and Al-Fe. Outstanding property of Al-Ni and some other intermetallics is the increase in yield stress with temperature [2]. The aim of the study is structural characterization of the Al-Ni system partialy doped with paladium. The structure of Al-Ni-Pd alloys was investigated by HRPD instrumentation available at the P0 2.1 beamline of PETRA III storage ring (Hamburg, Germany). Diffraction experiments were performed in transmission mode. The energy of the synchrotron radiation was set to 59.8 keV. The samples were illuminated with an incident beam having a cross section of 0.5x0.5 mm². Two dimensional (2D) diffraction patterns were collected using a fast detector Perkin Elmer 1621 carefully mounted orthogonal with respect to the incident X-ray beam. CeO₂ standard was used to calibrate the sample-to-detector distance and tilt of the flat panel detector relative to the beam path. Constant rate heating experiments were done using a Linkam THMS600 hot stage. Time resolved diffraction measurements of powder samples were realised from room temperature up to 600 °C with heating rate of 10 Kmin⁻¹. Exposure time was set to 1s. In order to reduce amount of data and increase signal-to-noise ratio, 20 successive patterns were averaged. Final temporal resolution was three 2D XRD patterns per minute which corresponds to the temperature step of 3.33 °C between two successive XRD patterns. Figure 1 shows series of XRD patterns recorded during constant rate heating experiment from room temperature up to 600 °C with a heating rate 10 Kmin⁻¹. Most pronounced Bragg peaks belong to bcc AlNi phase, S.G: Pm3m#221, a=0.291 nm. One can see that increasing temperature causes slight shift of Bragg peaks toward lower 2θ values, which is due to thermal expansion behavior. For a better structural and chemical description of the investigated alloy the scanning electron microscopy (SEM) and energy dispersive X-Ray spectroscopy (EDX) were used. Thermal properties of the alloy were investigated by differential thermal analysis (DTA) and thermogravimetry (TG). Elaboration of the obtained data is in progress.
Figure 1: In-situ, time resolved diffraction patterns recorded from room temperature up to 600 °C with a heating rate of 10 Kmin⁻¹. Bragg peaks of the highest intensity (marked with Miller indices) belong to bcc AlNi phase, S.G: Pm3m#221, a=0.291 nm.

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