phases associated with intriguing solid-phase transformations),
the atomistics of interfacial structure and growth mechanisms of many
precipitate phases remains poorly understood.

Here we present a structural study by aberration-corrected scanning
transmission electron microscopy (STEM) of Al-Cu precipitate phases
in several model aluminum alloys. These phases, Guinier-Preston (GP)
I zones, \( \theta^\alpha \) (Al-Cu) and \( \theta^\alpha \) (Al-Cu) phases, are classic crystalline
precipitates of the simplest age-hardened alloys [1], [2]. Using a
combination of experimental and simulated high-angle annular-dark-
field STEM imaging, we demonstrate that these well-known phases in
fact exhibit structural features hitherto unreported. Atomic-scale models
of interfacial structures are provided. Furthermore, trace additions of
Sn are shown to result in precipitate nanoscale thicknesses exhibiting
“magic” values. These findings resolve a long-standing mystery [3]
and provide new insights into the atomistic mechanisms of precipitate
growth in these systems.


Keywords: aluminium, precipitate interface, TEM.

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A simultaneous multiple angle-wavelength dispersive X-Ray
reflectometer

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In previous studies [1], [2], [3], we reported a method of measuring
specular X-ray reflectivity curves with no need of angle scanning of
the sample, detector and monochromator crystal during the measurement.
In this method, the reflectivity curve is measured with a position
sensitive detector as a function of X-ray energy using a convergent
X-ray beam which has a one-to-one correspondence between direction
and energy. Because the practically covered energy range was limited,
the measured range of the momentum transfer \( q = 4 \pi \sin \theta / \lambda \) ( \( \theta \) being the glancing angle and wavelength of the X-ray beam) was not
wide enough for quantitative analysis.

In the present study, we report improvements of the method for
widening the simultaneously covered range of the momentum transfer
by realizing a convergent X-ray beam with which the wavelength (energy)
and the glancing angle to the specimen surface of the X-ray beam
change continuously at the same time as a function of direction. For
realizing such a convergent beam, we used a bent and twisted crystal.
An inclined slit is placed upstream of the crystal, so that the foot print of
an X-ray beam is along a line from the upper left to lower right corners
of the crystal. The crystal is elliptically bent in the horizontal plane
and furthermore twisted around the cross line of the crystal surface
and the horizontal plane. The beam reflected at the upper left corner
is slightly deflected downward, while that at the lower right keep the
same vertical direction. Another big improvement is the use of a pixel
array detector (PILATUS 100K) instead of an X-ray CCD.

Reflectivity curve profiles from a silicon wafer were simultaneously
recorded covering a \( q \) range from 0.05 to 0.5 \( \AA^{-1} \). Measured minimum
reflectivities were \( 1 \times 10^{-6} \) and \( 1 \times 10^{-8} \) with data collection times
of 100 s and 1 s, respectively.

We will report results of a performance test experiment and
discuss means to further improve the performance of the reflectometer
including the time resolution.

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Key words: X-ray reflectivity curve, simultaneous measurement,
multiple angle-wavelength dispersive

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Long-range order and interface stability in CoFeSi/GaAs hybrid
structures

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Ferromagnet/semiconductor hybrid structures are well suited for
spin injection as a first step towards the design of spintronics devices.
The half-metallic and ferromagnetic Heusler alloy CoFeSi exhibits
a high degree of spin polarization as well as a large Curie temperature of
about 1,100 K and is perfectly lattice matched to the semiconductors
GaAs and Ge. Spin injection has already been demonstrated. The
properties of the ferromagnet/semiconductor interface and long-
range order in the Heusler alloy are important for an improvement
of the spin injection efficiency. The CoFeSi structures on GaAs are
grown by solid source molecular beam epitaxy. The long-range order
and the interface stability of the structures are investigated by trans-
mission electron microscopy (TEM), X-ray diffraction, atomic force
microscopy (AFM) and secondary ion mass spectrometry. At high
substrate temperature \( T_0 \) during growth, a precipitation process near
the CoFeSi/GaAs interface is observed, which is connected to an
denhanced diffusion of Co, Fe, and Si into GaAs. We use the value of \( T_0 \)
at which precipitation begins as the limit of the interface stability.
The critical value of \( T_0 \) depends on the crystallographic orientation of the
interface. For \( \{001\} \) and \( \{110\} \) interfaces, these temperatures are near
\( T_0 = 250^\circ \text{C} \) and \( T_0 = 200^\circ \text{C} \), respectively, whereas for the \( \{111\} \) interface
this temperature limit is considerably higher: \( T_0 = 325^\circ \text{C} \). As a result,
the \( \{111\} \) interface is the most stable interface, and an overgrowth of
the ferromagnetic film with Ge could be possible for this orientation
[1]. The figure demonstrates the surface roughness of the CoFeSi film
measured by AFM for two orientations of the interface (110 and 111)
and several growth temperatures \( T_0 \). For a quantitative characterization
of long-range order we determine the average order parameters in CoFeSi using x-ray diffraction
and image the lateral inhomogeneities of the compositional order in the
films on the nanometer scale using the dark-field mode of TEM with
superlattice reflections. A fundamental reflection is insensitive to long-
range order, and the dark-field image of that reflection is usually almost
homogeneous. A superlattice reflection images the distribution of long-