ESRF	**Experiment title:** In-situ study of the nucleation and growth of individual pearlite colonies during the austenite-pearlite phase transformation in steel.	**Experiment number**: ME-267
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Report:

A long-standing problem in the field of steel technology is the modeling of the austenite-pearlite transformation kinetics. Pearlite is the product of an eutectoid decomposition, in which the austenite is transformed into colonies composed of alternating plates of ferrite and cementite (Fe_3C). A pearlite colony effectively consists of two interpenetrating single crystals of ferrite and cementite in which the alternate plates from either phase in a colony have the same orientation and each phase forms a continuous network. The first attempts to model the austenite-pearlite transformation date back several decades and are described by the classical Johnson-Mehl-Avrami theory. Despite continuous efforts in recent years the predictive power of these models is still limited as they strongly depend on the physical properties on a microscopic scale, which are not sufficiently known. In particular the balance between nucleation and growth kinetics is poorly understood and only the weighted overall behavior has been determined. The aim of these experiments is to identify the physical parameters that characterize the nucleation and growth mechanism of pearlite colonies in the austenite matrix during continuous cooling and isothermal transformations.

In order to study the volume of individual pearlite colonies as a function of time we used the diffraction instrument ID11 in transmission geometry with a 2D detector and a photon energy of 80 keV. The behavior of a pearlite colony was studied by monitoring the Bragg reflections from the ferrite phase. For a low number of pearlite colonies per illuminated volume, the Bragg peaks of the individual pearlite colonies appeared as separate spots on the 2D detector. The intensity is proportional to the volume of the growing colony. To prevent that the spots overlap, a limited number of grains was illuminated by choosing an appropriate beam size of 100×100 μm^2. The samples with a thickness of about 400 μm were heated in a vacuum furnace at 900 ^oC for 10 min, in order to form single-phase austenite. During the continuous cooling experiments the samples were cooled at a rate of 5 $^oC/s$ to 600 ^oC. For the isothermal transformations the samples were cooled at a rate of 10-20 $^oC/s$, to a temperature just below the austenite-pearlite transformation temperature of 723

^{o}C, were the temperature was kept constant for about 1 hour. This procedure was repeated for different undercoolings, in order to study the temperature dependence of the nucleation and growth. The transformation behavior of three carbon steels was studied, with carbon concentrations of 0.22, 0.60, and 0.80 wt%.

Here we present the first results of measurements on a 0.22 wt% carbon steel during continuous cooling. The measured ferrite grain volume was converted to the grain radius by assuming that the ferrite grain is spherical. Fig. 1 shows the measured growth curves of three individual ferrite grains during the phase transformation, while the 0.22 wt% carbon steel was continuously cooled. The austenite/ferrite transformation starts at around 822 ^{o}C and the austenite/pearlite transformation starts at 685 ^{o}C. The figure shows that the ferrite grains continue to grow with the *same* crystallographic orientation during the pearlite formation as part of a pearlite colony. These growth curves also show that the pearlite colony reaches a larger final size when the initially formed ferrite grain is smaller.

In the near feature the other measurements will be analysed, which include isothermal transformation experiments at different temperatures and continuous cooling experiments for the three steel grades. The observed transformation behaviour will be compared with the existing phase transformation models.

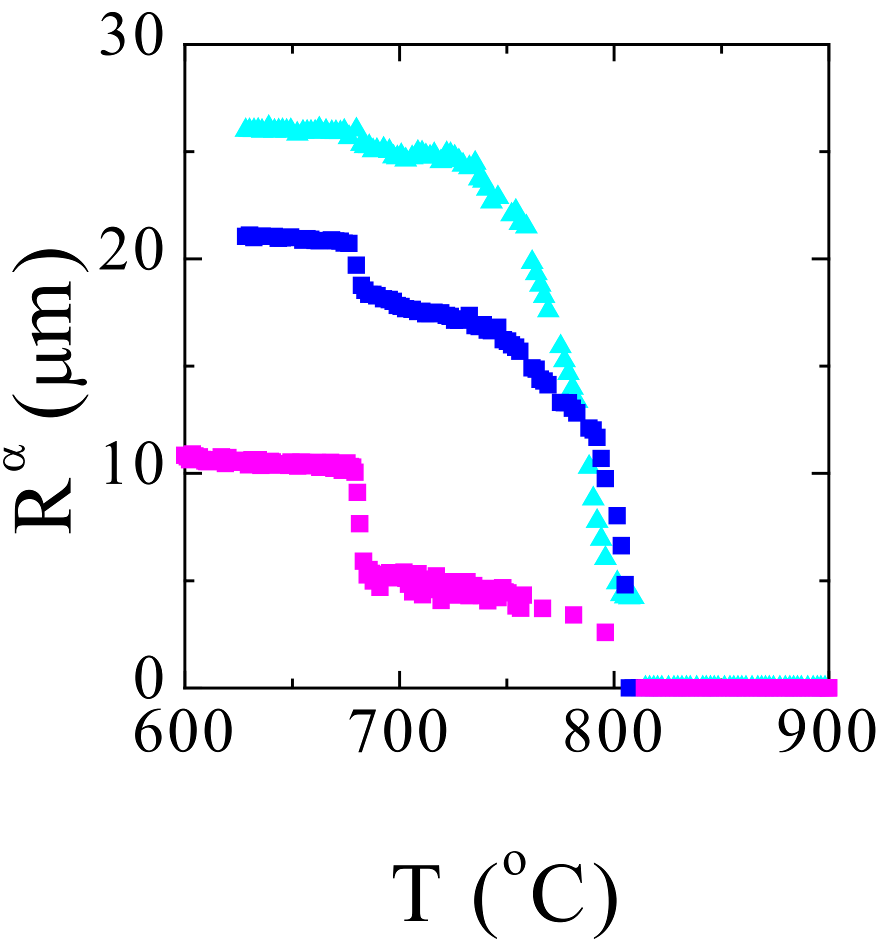

***Fig. 1**: The radius R^{α} of three individual ferrite grains as a function of temperature during the phase transformations in a 0.22 wt.% C steel. The sample was cooled at a rate of 5* ^{o}C/s.