Introduction
Due to its high mobility for electrons and holes, Ge is regaining importance as active layer in semiconductor technology. Its basic defect properties are less studied than those of Si. Quenching experiments in principle allow to determine the activation energy and diffusion constant of vacancies in Ge. In this context it is important to identify the defects formed upon quenching. We report a Deep Level Transient Spectroscopy (DLTS) characterization of quenched Ge samples. Three prominent DLTS peaks are observed after quench. One of them can be annealed out at 280°C. For the remaining two peaks a detailed comparison is made with literature data for substitutional Cu, since it is difficult to avoid this impurity when quenching Ge.

Experimental
P-type germanium (6 ×10^{15} cm^{-2}) was used. Samples (10 ×10 ×0.2 mm) were put in a preheated tube furnace (temperature T_{furn}) during 60 minutes, after which they were quenched in helium at room temperature (25°C)

Some quenched samples were additionally annealed in the same oven at 280°C during 60 minutes. The samples where etched (HF+HNO_{3}) and prepared for DLTS measurements by evaporating In to form Schottky junctions. Ohmic contacts were prepared using In-Ga eutectic and silicon oil at room temperature (25°C). The samples where etched (HF+HNO_{3}) and prepared for DLTS measurements by evaporating In to form Schottky junctions. Ohmic contacts were prepared using In-Ga eutectic and silicon oil at room temperature (25°C).

Influence of quenching Temperature
Van der Pauw measurements:
p(700°C) = 6.42 ×10^{12} cm^{-2}
p(800°C) = 6.04 ×10^{12} cm^{-2}

Effect of annealing
DLTS spectrum of sample quenched from 600°C before and after annealing at 280°C. (T_{furn}=5.12 ms)

Conclusions
The three most prominent deep levels in the lower half of the band gap of quenched p-type germanium have been characterized using DLTS. At first glance the similarities of the H(017) and H(140) levels with those of substitutional copper are striking. A detailed analysis of the properties of H(140) using isothermal DLTS reveals, however, remarkable differences. The field enhanced emission, which does not obey the Poole Frenkel law, and the capture cross section, which strongly deviates from the one observed for Cu, suggest that other assignments (e.g. vacancy related centres) may have to be considered.

References