Introduction
Since loaded polymer products eventually always fail, it is important to understand the failure mechanisms and be able to predict how and when failure takes place. Typically two regimes are distinguished: 1) plasticity controlled, ductile failure and 2) crack growth controlled brittle failure (Fig 1). As time-scales are rather large, time-temperature-superposition (TTS) is used to accelerate failure in regime 1 and dynamic loading to accelerate in regime 2 [1].

Objective
The main objective of this work is to investigate whether dynamic loading conditions can be used to accelerate failure of isotactic polypropylene in the brittle failure regime.

Results
Uniaxial creep experiments were performed to obtain the failure kinetics and to find the transition from ductile to brittle failure (Fig. 2). Brittle failure takes place at shorter times for increasing temperature, i.e. the transition is temperature dependent. Dynamic experiments (maximum applied stress is 10 times the minimum \( R=0.1 \)) show that the application of sinusoidal loads decreases the time-to-failure for both ductile and brittle failure. This suggests that both mechanisms are plasticity controlled.

Discussion and conclusion
It is found that the brittle failure, in literature described as crack growth controlled is definitely not crack growth [2]. From our findings it can be concluded that the failure mechanism at hand is dominated by plasticity controlled voiding. Formation and coalescence (and/or growth to a limited extend) finally result in failure. Burst pressure experiments show a phenomenon called “weeping”, i.e. the appearance of “tears” on the outside of pipe specimens, in the transition from ductile to brittle failure. Percolation of voids could be the cause for this porosity.

Future work
• X-ray experiments allow to follow the cavitation process.
• Test at multiple R-values to show if weeping is a mixed failure mechanism.

References