Technische Hochschule Ingolstadt

Fakultät für Maschinenbau

Zukunft in Bewegung

Deformation behaviour of brass alloys at 150°C

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Objectives

Motivation:

Brass alloyed with lead finds its application since many years in bearings and machining. Besides the possibility to embed wear debris in the soft lead phases, lead lowers the friction coefficient of the tribological system and provides at mixed friction conditions dry-running properties. Moreover in fittings, screw joints and other parts which are subjected to temperature brass alloys are used. Therefore the creep and the stress relaxation behavior becomes relevant. The motivation for this investigations was to compare the influence on temperature on the properties of different brass alloys.

Investigated Alloys

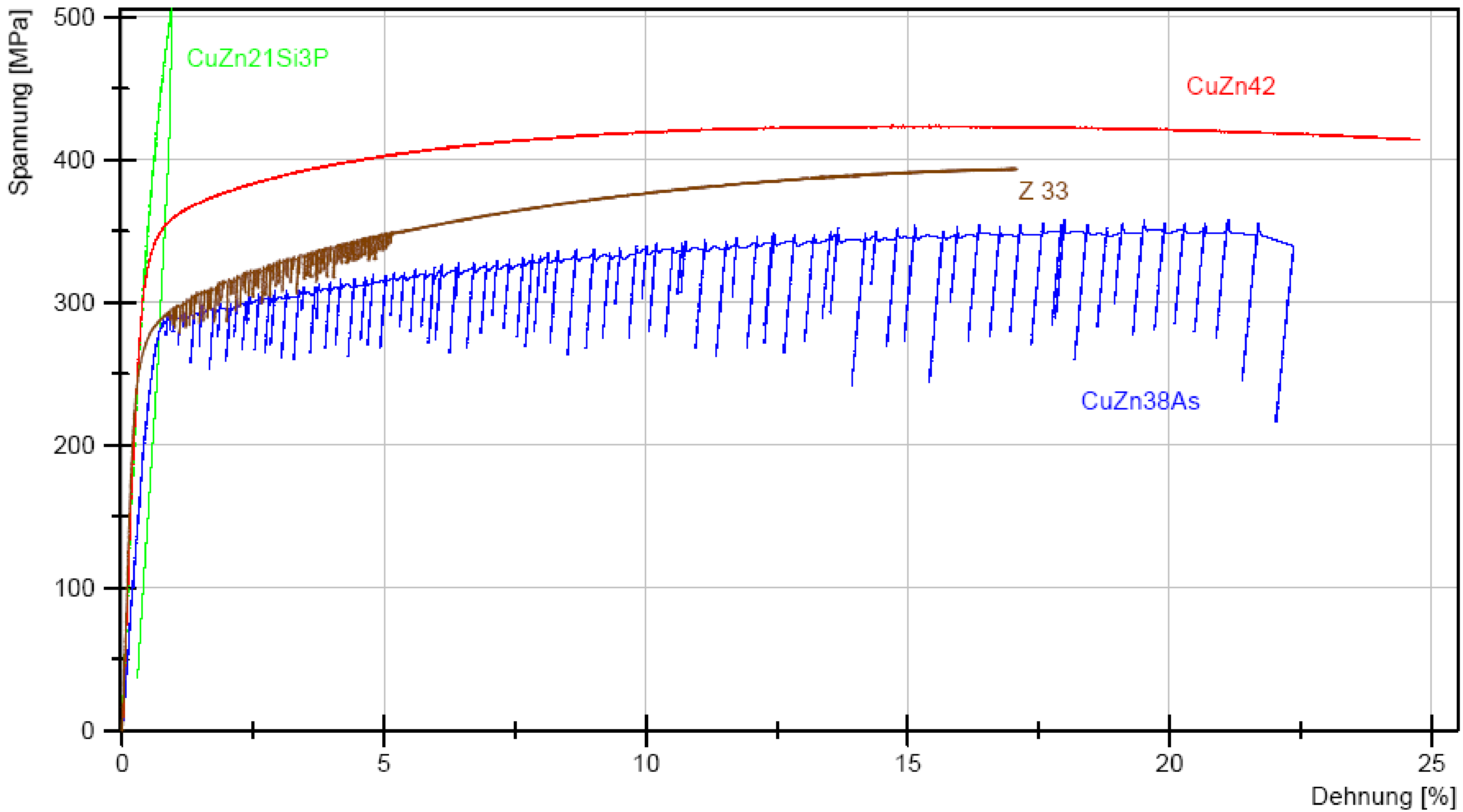
- Z33 (CuZn39Pb3) , α-brass alloy containing lead phases, the Zn amount offers the highest possible solid solution strengthening in the Cu-Zn-System
- CuZn21Si3P, α-brass alloy containing silicon phases
- CuZn38As, α-brass alloy (dezincification resistant)
- CuZn42, α/β-alloy with a small amount of precipitates containing the elements Fe, Si, Mn

Experiments

- Tensile tests at 150°C were performed with an Instron universal test machine with a constant strain rate. Most important was the determination of the yield strength which is necessary to calculate the stresses for the creep experiments
- Creep tests were performed with a Mayes creep machine with a constant load. The stresses were calculated due to the given specification (T=150°C,t=1000h,σ= 80% of yield strength at 150°C)
- Brinell hardness measurements (HBW 2,5/187,5) at room temperature (RT)

Tensile test of different brass alloys at 150°C

Measurements



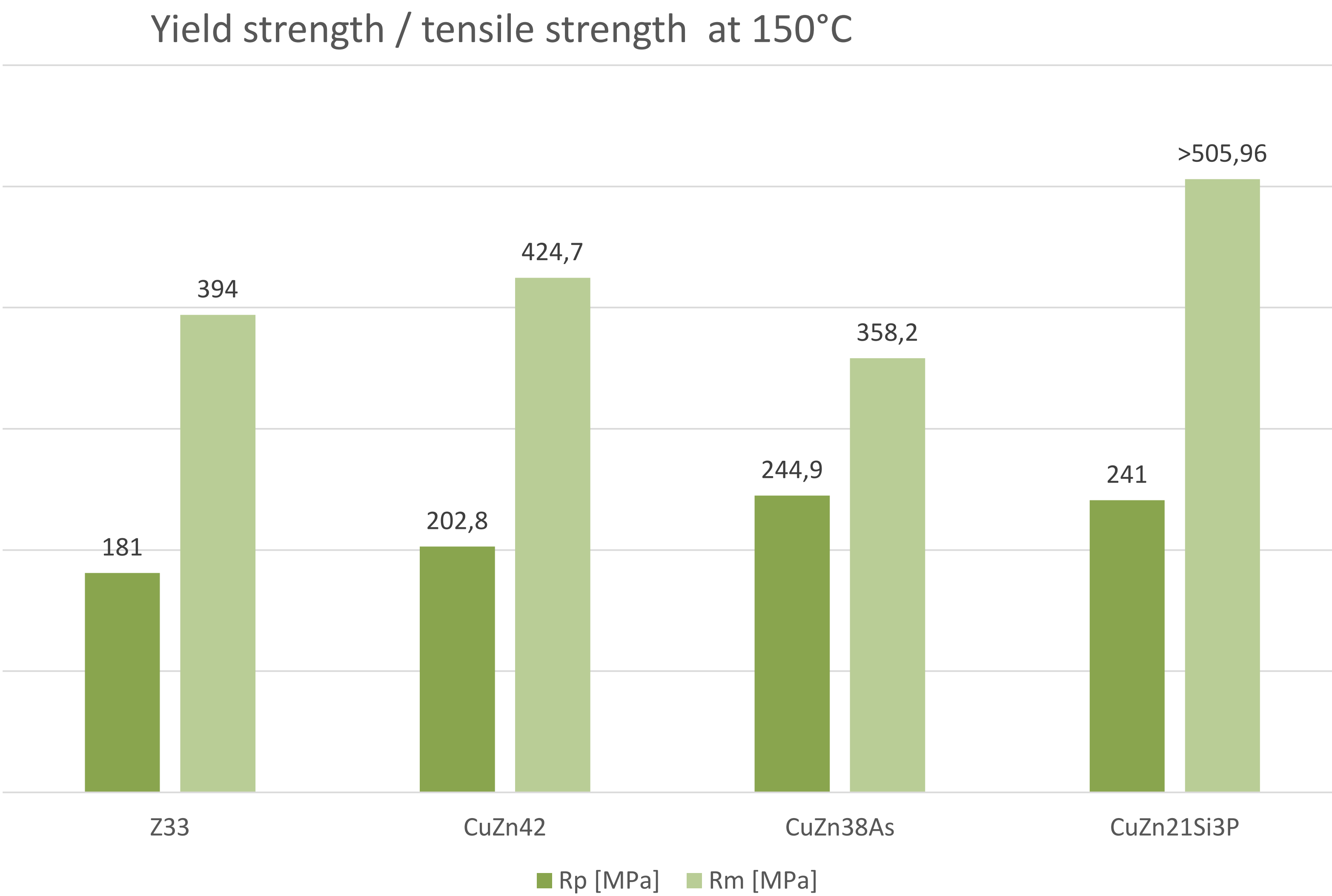
Tensile test of different brass alloys at 150°C

Discussion of results

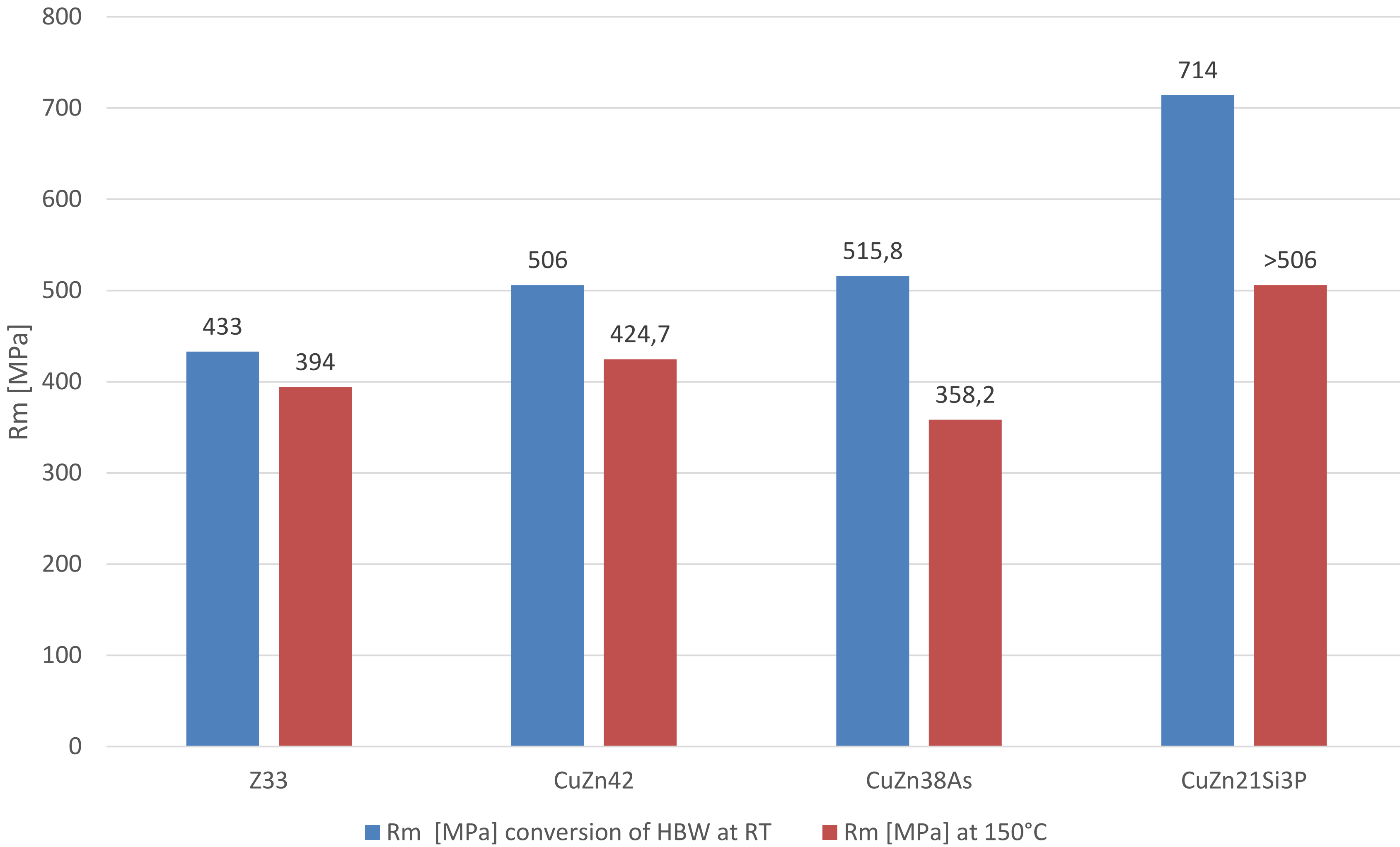
- A good explanation for the result of the tensile test at 150°C can be given by regarding the different Zn content of the alloys:
    - Zn content: CuZn42> Z33 (CuZn39Pb3) > CuZn38As
    - as higher the Zn content as better the solid solution hardening up to ca. 40 %
    - at Zn concentration higher the possibility of precipitate hardening is given by them formation of the β-Phase
    - consequently with a higher Zn content results in higher strengths by tensile test experiments

- The highest strength shows the CuZn21Si3P alloy, which can be attributed to the intermetallic phases Cu_4ZnSi or Cu_8Zn_2Si

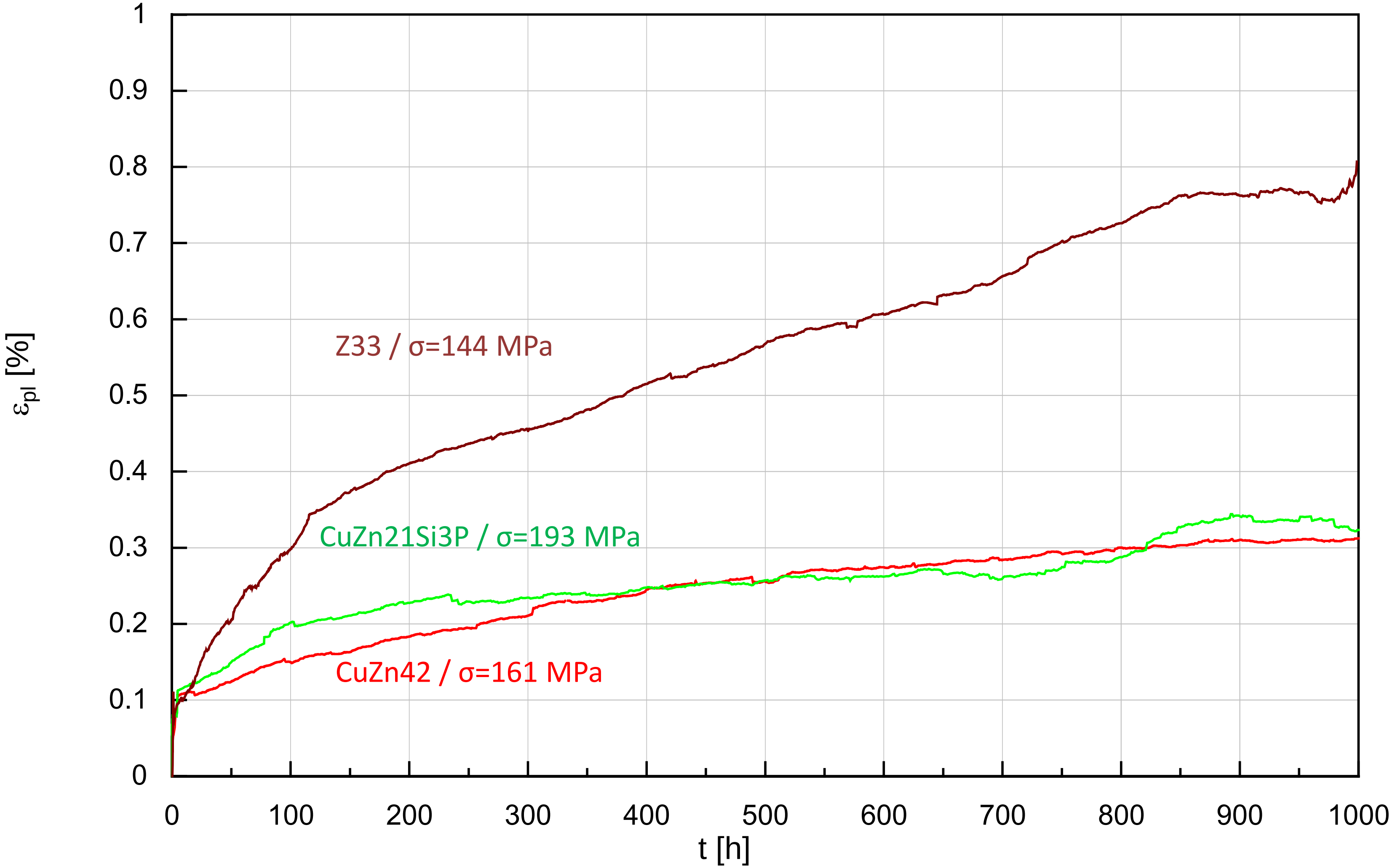
Yield strength /tensile strength of different brass alloys at 150°C



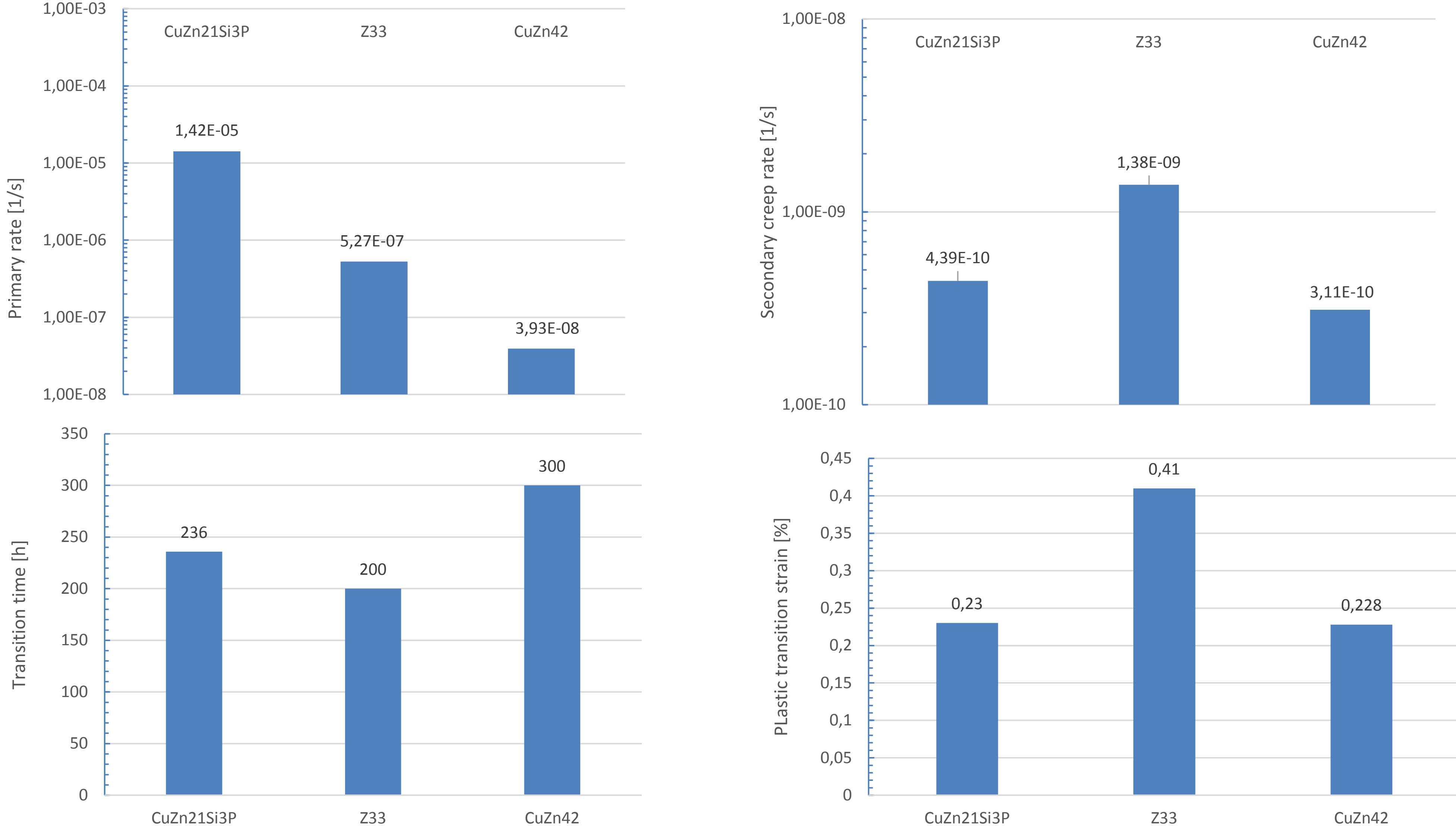
Tensile strength of different brass alloys at RT compared to 150°C



Creep experiments 1000h at 150°C



Creep experiments - results



Discussion of creep results

- The lead free alloys CuZn42 and CuSi21Si3P show much less creep strain compared to the lead containing Z33. An explanation for this behaviour is given by the lead phases which are segregated at the grain boundaries, which weakens the grain boundaries and causes grain boundary sliding.
- The primary creep rates drop with an increasing amount of Zn. Zn produces solid solution hardening in the α-crystals.
- Lead enhances strongly the secondary creep rate compared to the lead free alloys, which can be attributed to grain boundary effect like grain boundary sliding
- The strain at which the transition from primary to secondary creep becomes for the lead free alloys quite the same. This is in accordance to the literature, where a certain amount of strain is necessary for the formation of subgrains. If the subgrain formation is completed the secondary creep gets dominant
- The lead containing alloy Z33 has a higher transition strain compared to the lead free alloys CuZn42 and CuSi21Si3P, which can be explained by grain boundary effects of lead
- The longest time for the transition could be measured for CuZn42 which can be explained by the lowest primary creep rate