Profile LFR-32

CRISLA

GERMANY

GENERAL INFORMATION

NAME OF THE FACILITY	Creep-to-rupture tests in stagnant lead alloys
ACRONYM	CRISLA
MEDIUM (COOLANT(S)) OF THE FACILITY	Lead, lead–bismuth eutectic
LOCATION (address):	Karlsruhe Institute of Technology (KIT) Hermann-von-Helmholtz-Platz 1 Bldg. 618 76344 Eggenstein-Leopoldshafen Germany
OPERATOR	Liquid Metal Technology Group of the Institute for Applied Materials -Applied Materials Physics (IAM-AWP)
CONTACT PERSON(S) (name, address, institute, function, telephone, email):	Dr. Carsten Schroer Karlsruhe Institute of Technology (KIT) Institute for Applied Materials -Applied Materials Physics (IAM-AWP) Head of Liquid Metal Technology Group +49 721 608 24840 carsten.schroer@kit.edu

STATUS OF THE FACILITY	In operation
Start of operation (date):	2007

MAIN RESEARCH FIELD(S)

- ☐ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☐ Thermal-hydraulics
- ☐ Coolant chemistry
- ☒ Materials
- ☐ Systems and components
- ☐ Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

CRISLA is a testing rig for investigating creep and stress rupture of steels in static liquid lead or lead–bismuth eutectic (LBE) as well as in static air. It consists of 8 load frames, five of which are equipped with the gas supply, data acquisition and monitoring system required for automated control of the oxygen content in liquid metals using gas/ liquid oxygen transfer. For both tests in liquid metal and air, the specimen of the material tested resides in a steel capsule. The pull rod for applying a static tensile load is integrated in the lid of the capsule, with flexible bellows facilitating the transfer of mechanical load onto the specimen. At the same time, the bellows allows the pull rod to move. The elongation of the specimen is identified with the movement of the pull rod and determined outside the capsule. While performing the test in a closed containment is necessary in the case of liquid metal with defined oxygen content, the tests in air are performed in a steel capsule in order to have similar experimental factors possibly influencing the test results. The tests in air primarily serve as a reference for determining the effects of lead or LBE.

The main components of the capsules are made of austenitic stainless steel (DIN W.-Nr 1.4571 or X6CrNiMoTi17-12-2). The ones for experiments in liquid metal are somewhat larger than those for tests in air and contain about 9 kg lead or LBE. An electrochemical oxygen sensor with platinum (Pt)/ air reference electrode measures the actual oxygen chemical potential in the liquid metal. The latter is influenced by introducing oxygen-rich or -depleted gas into the capsule. Commercial λ-probes monitor the oxygen partial pressure in the gas that enters or leaves the capsule. The gas may be introduced either above or below the liquid metal surface.

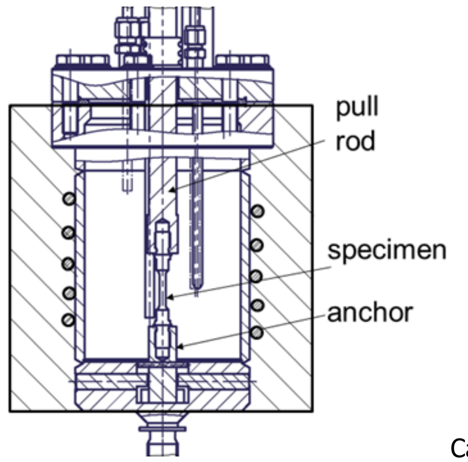
For the experiments in lead or LBE, the capsule is first filled with liquid metal and pre-conditioned with respect to dissolved oxygen. The capsule is opened at a temperature around the melting point of the liquid metal and the specimen is introduced. Afterwards, the capsule is integrated into the load frame, heated to the temperature of the test and conditioned with respect to dissolved oxygen, before the test load is applied.

The operating temperature of the CRISLA capsules is limited to 650 °C. Usually, tensile specimens with circular cross section and gauge diameters of 3 or 4 mm are employed.

Acceptance of radioactive material

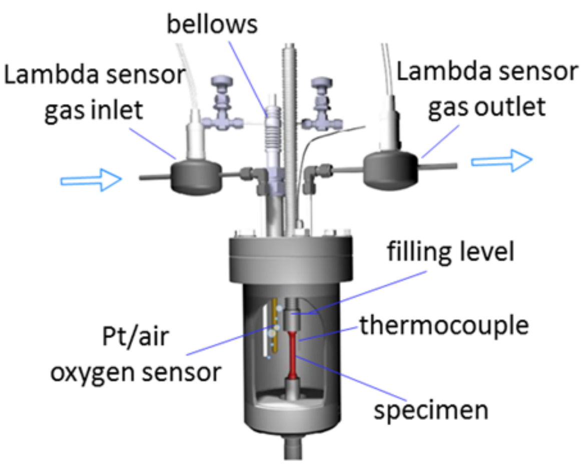
No

Scheme/diagram



Capsule for tests in liquid metal.

3D drawing/photo



Capsule for tests in liquid metal.

Load frames.

Parameters table

Medium (Coolant) inventory	9 kg per test capsule
Power	n/a
Test sections	
TS	<u>*Characteristic dimensions*</u> Ø112 × 126 mm (diameter × height of space inside the capsule)
	<u>*Static/dynamic experiment*</u> Static
	<u>*Temperature range in the test section (Delta T)*</u> 400–650 °C (quasi-isothermal)
	<u>*Operating pressure and design pressure*</u> Ambient
	<u>*Flow range (mass, velocity, etc.)*</u> n/a

Medium (Coolant) chemistry measurement and control (active or not, measured parameters)	Automated control of dissolved oxygen using gas/ liquid oxygen transfer
Instrumentation	Electrochemical oxygen sensor, thermocouple, λ-probes

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Stress rupture of ferritic/ martensitic steels (T91, P92, ODS steels) in lead at 650 °C and 10^{-6} % (by mass) oxygen dissolved in the liquid metal.

Creep of T91 in LBE at 450–550 °C and $\leq 10^{-7}$ %dissolved oxygen.

Creep and stress rupture of austenitic steels 316L, 1.4970 and austenitic ODS steel in LBE and lead, respectively, primarily at low concentration of dissolved oxygen.

The experiments in the CRISLA facility contributed to the European research projects GETMAT, MATTER and MATTISSE.

PLANNED EXPERIMENTS (including time schedule)

Austenitic steel 1.4970 after thermo-mechanical pre-treatment in LBE at low oxygen content (2019/ 2020).

TRAINING ACTIVITIES

Depending on availability

REFERENCES (*specification of availability and language*)

1. M. Yurechko, C. Schroer, O. Wedemeyer, A. Skrypnik, J. Konys, Creep-to-rupture of 9%Cr steel T91 in air and oxygen-controlled lead at 650 °C, Journal of Nuclear Materials 419 (1–3) (2011) 320–328.
2. M. Yurechko, C. Schroer, A. Skrypnik, O. Wedemeyer, J. Konys, Creep-to-rupture of the steel P92 at 650 °C in oxygen-controlled stagnant lead in comparison to air, Journal of Nuclear Materials 432 (1–3) (2013), 78–86.
3. M. Yurechko, C. Schroer, A. Skrypnik, O. Wedemeyer, J. Konys, Creep-to-rupture of 12Cr- and 14Cr-ODS steels in oxygen-controlled lead and air at 650 °C, Journal of Nuclear Materials 450 (1–3) (2014), 88–98.
4. M. Yurechko, C. Schroer, O. Wedemeyer, A. Skrypnik, J. Konys, Creep-rupture tests on chromium-containing conventional and ODS steels in oxygen-controlled Pb and air at 650 °C, Nuclear Engineering and Design 280 (2014) 686–696.
5. M. Yurechko, C. Schroer, A. Skrypnik, O. Wedemeyer, V. Tsisar, J. Konys, Steel T91 subjected to static stress in lead–bismuth eutectic at 450–550 °C and low oxygen concentration, Journal of Nuclear Materials 512 (2018) 423–439.