

# Recovery of rare earth elements (REE) and platinum group metals from tailings and production residues

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Slags resulting from the pyrometallurgical processing of automotive catalytic converters often contain a variety of strategic metals such as rare earth elements (REE, especially cerium). Furthermore they contain small amounts of platinum group metals that were not extracted into the collective metal phase. Comparatively high fractions of lanthanum oxide can be found in wastes from the production of spectacle lenses, so called flint glass. These valuable and to some extent critical elements have not been recovered so far, because an adequate processing route from crushing over recovery to the reuse was missing. With our researches in this project, we are striving for a scientific basis, which aims at a closed material cycle of the above mentioned elements.

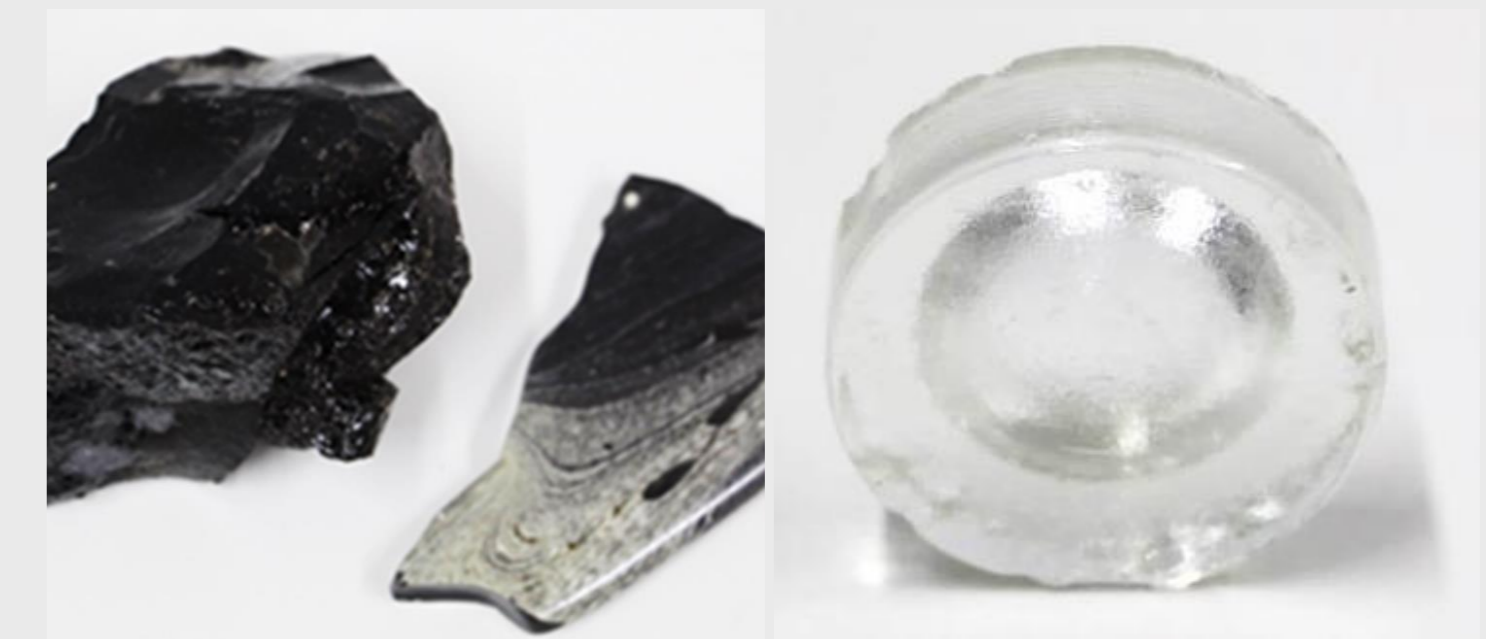
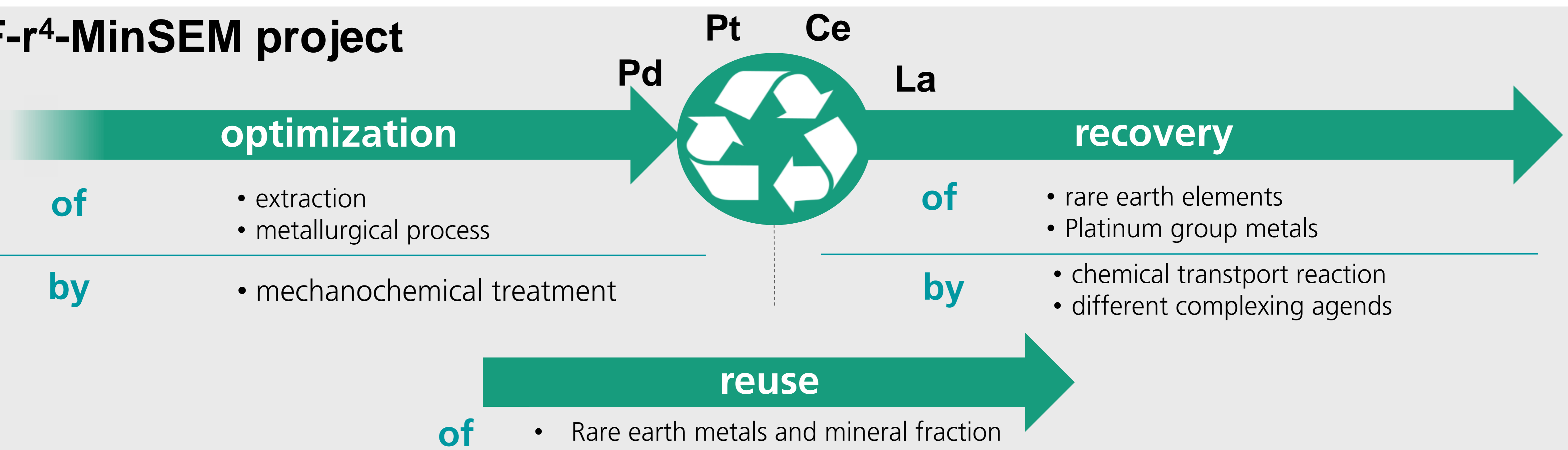


Fig 1. Catalyst slags (left), spectacle lenses (right)

## BMBF-r<sup>4</sup>-MinSEM project



## Recycling of autocatalysts

Monolite powder  
Slag  
Collective metal (Fe, Cu, Pb)

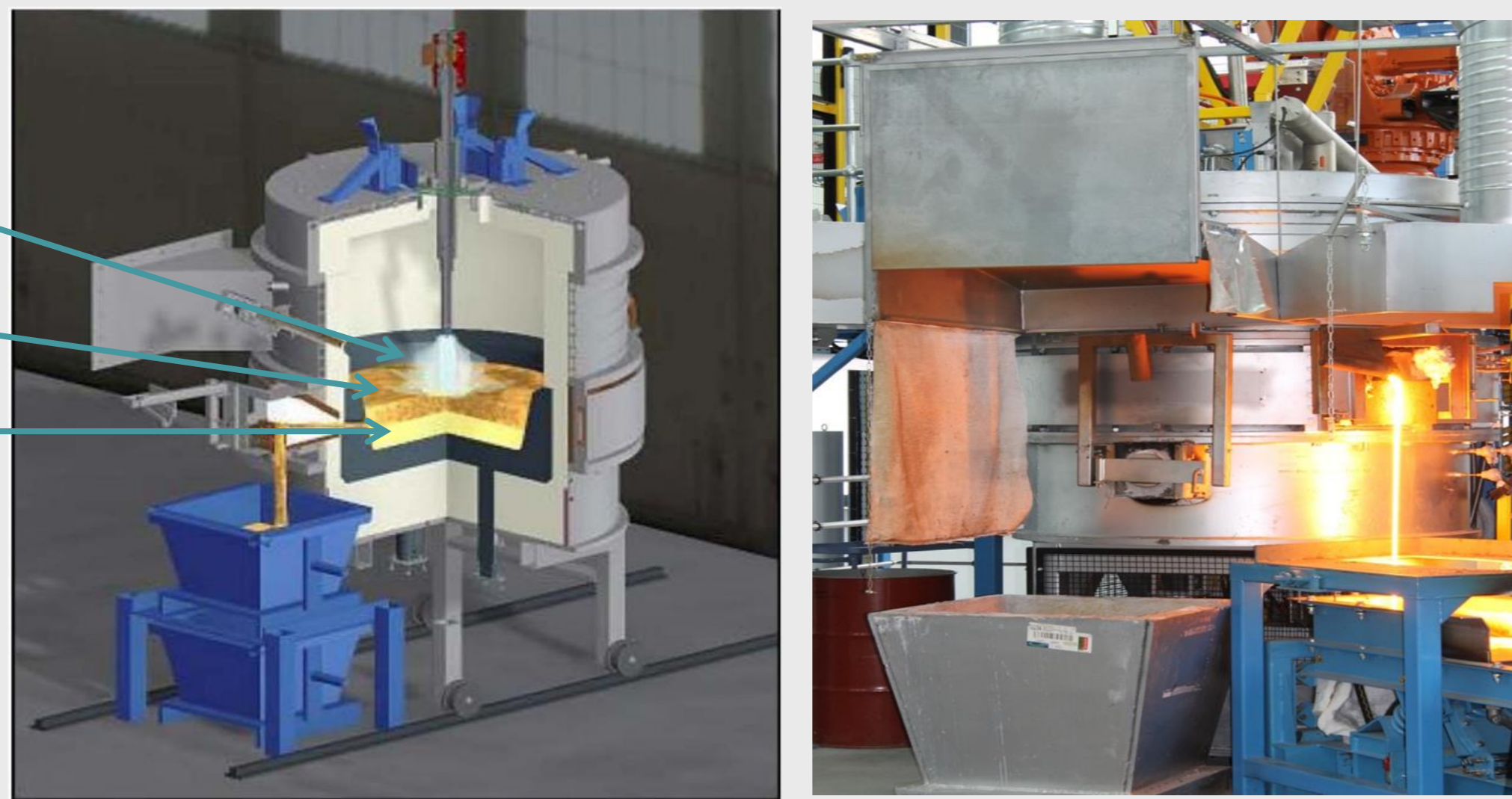


Fig 2. Plasma induction furnace (Hensel Recycling GmbH)

The recycling of automotive catalytic converters yields large quantities of slag containing REE in an extensive range of 3 % cerium and lanthanum, and also platinum group metals. In the melting process the metals like platinum, rhodium and palladium are separated in the first step. One ambition of our work is the recovery of REE from the slag. Furthermore, the melting process is investigated in the project with respect to a reduction of the platinum group metals in the slag.

## Production of flint glasses

The flint glasses consist of 7 % lanthanum (lanthanum glass) or 7 % neodymium, praseodymium in addition to 8 % erbium (erbium glass). The composition influences the subsequent refraction properties. The rare-earth metals thus recovered are to be used as oxides in the special-glasses production process as a feed material for the manufacture of high-tech products.

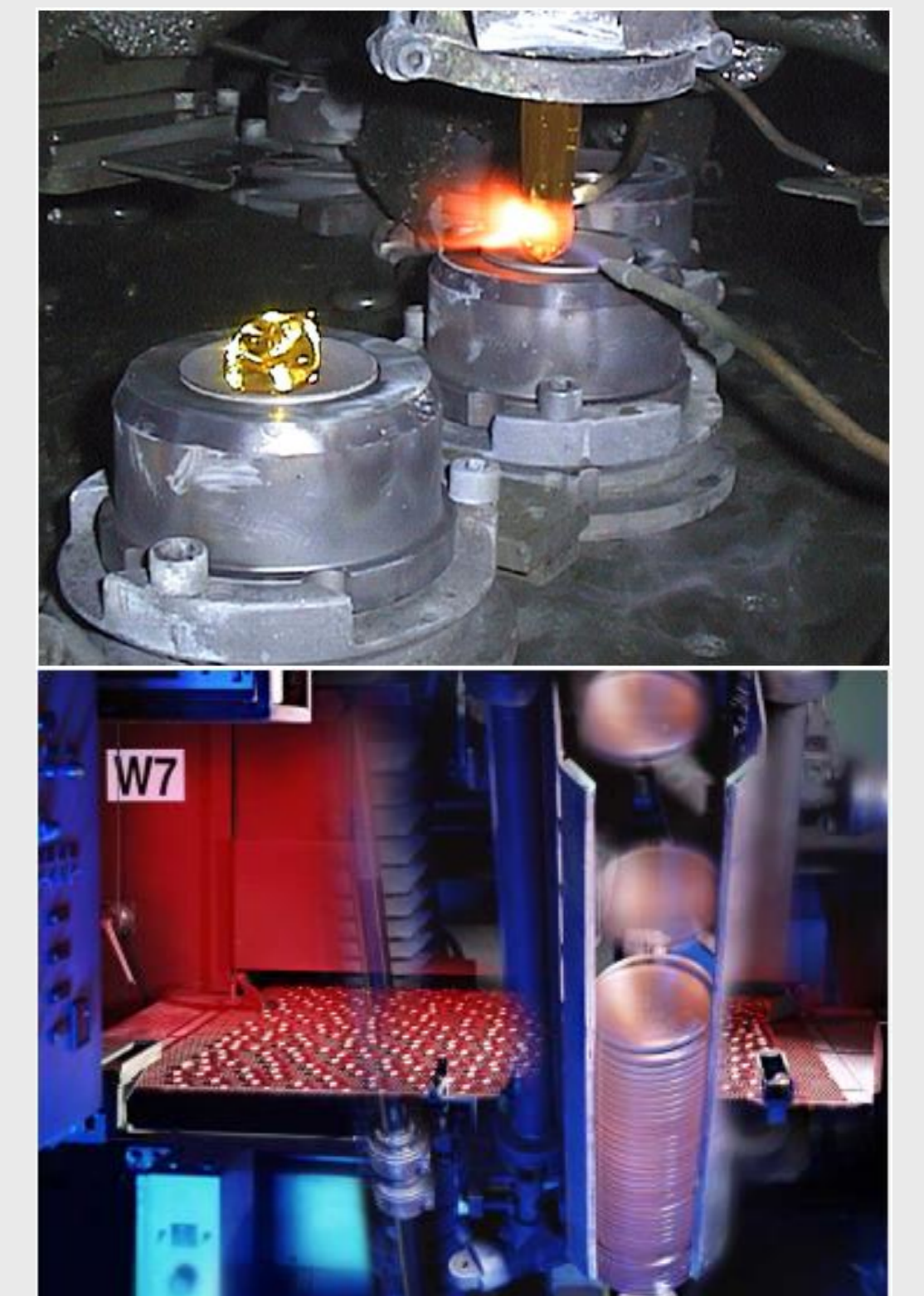


Fig 3. Production process of flint glasses; (Baberini GmbH)

## Mechanochemical leaching



Fig 4. Planet ball mill (Fraunhofer IWKS)

An innovative process, called mechanochemical leaching, is used for the recovery of rare earth elements. The slags and glasses are comminuted and mechanochemically processed with acids. A major advantage compared to conventional leaching is the use of weaker acids, up to 1M and a shorter leaching time, about 15 minutes. In addition, a higher solid concentration can be used for the recovery, with the secondary effect of a higher concentration of ions in the solution.

## Extraction process

The following wet-chemical treatment results in concentrated aqueous solutions, which are treated by means of "liquid-liquid extraction" processes, based on conventional organic complexing agents, like Bis(2-ethylhexyl)phosphate, and ionic liquids (TAAILs) in order to permit a separation of REE up to a demonstration scale.

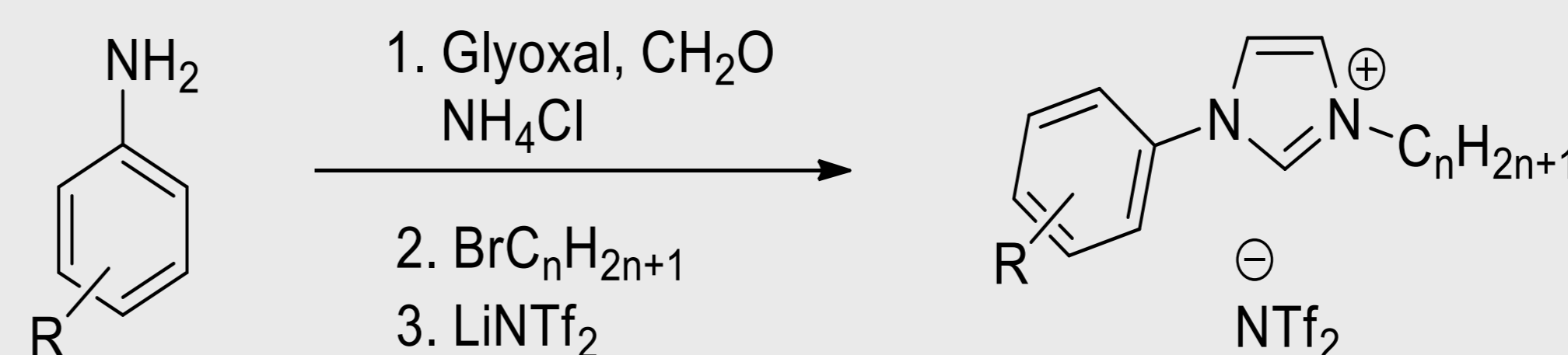


Fig 5. Synthesis of TAAILs (left) and extraction process (right); (TU Dresden)



## Gas phase reaction

In a second process tailored to the re-use of special glasses, the rare earth elements are selectively separated from the production residues by means of gas phase reactions (Fig. 6). This will generate rare earth compounds, which can, if necessary, be further processed using TAAILs or converted into oxides using thermal treatment to the oxides of the rare-earth elements.

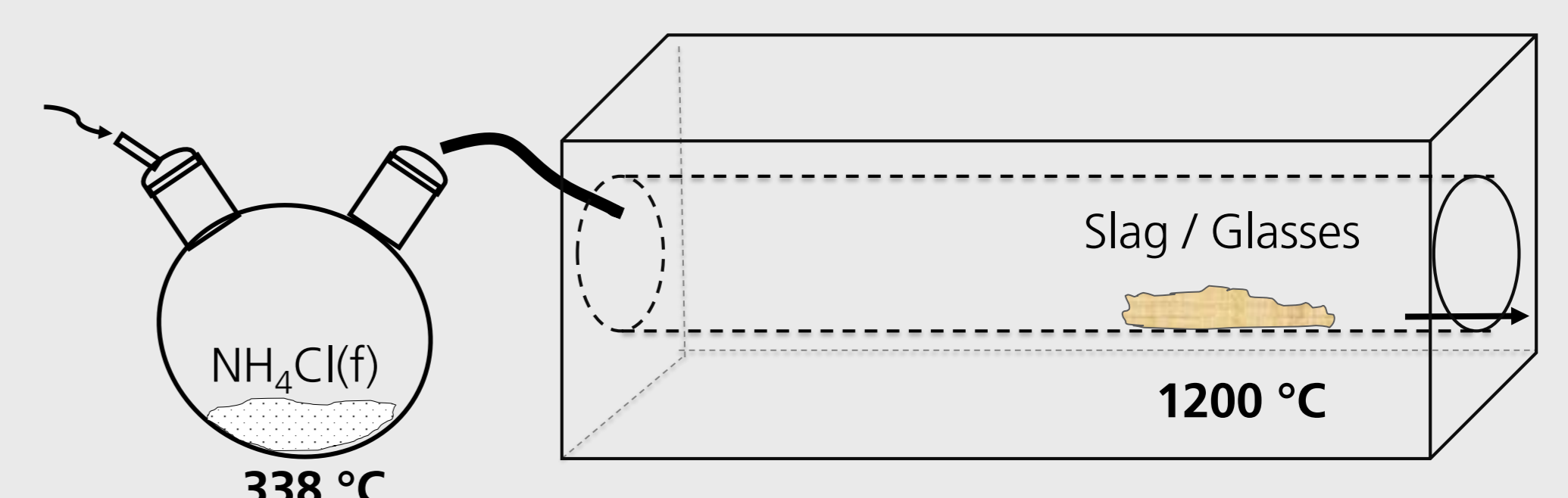


Fig 6. Gas phase reaction system