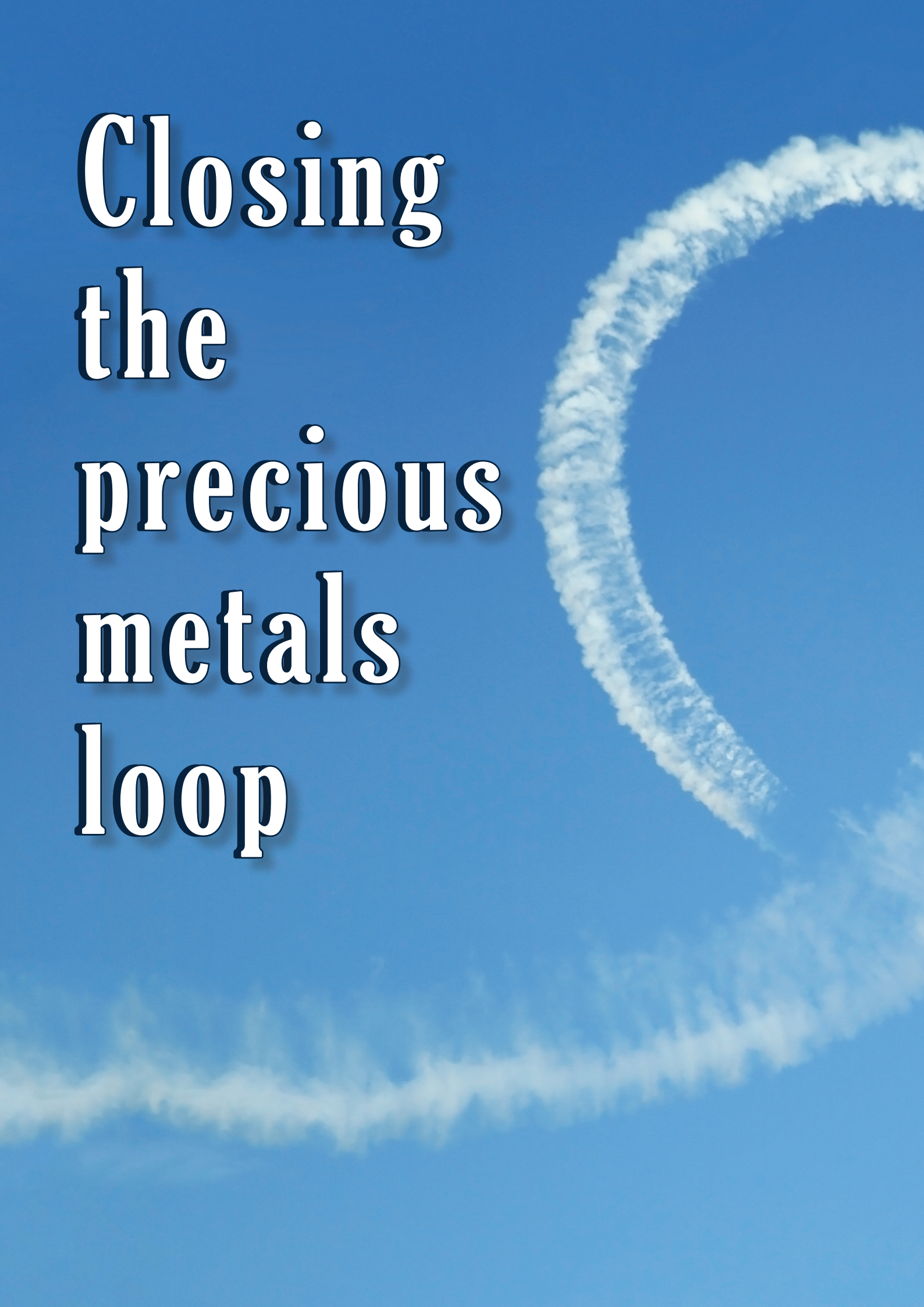
# Closing the precious metals loop



**Christoph Röhlich and Jens Hesse, Heraeus Precious Metals, Germany,** outline how the precious metals loop can be closed through sludge refining.

Some businesses work to close the loop of precious metals handling, from precious metal purchases and production of precious metal-based catalysts, to the refining of these catalysts and a variety of other sources.

A well-known example for this kind of loop business in the fertilizer industry is the production and refining of gauze catalysts for nitric acid producers. To close this loop entirely, the refining of plant cleaning sludges and the purchase of precious metals should be considered.

Another example of a precious metal loop business is the production and refining of carbon dioxide ($CO_2$) purification catalysts for urea producers.

For such precious metal loop businesses, it is vital to have a strong and trusted partner with a good track record, combining expertise and industry experience to provide customers with cost-effective, one-stop solutions.

## Securing precious metal sourcing

To check the quality of precious metal sourcing, the LPPM Good Delivery list[1] is a starting point. Future market demands can only be covered by a combination of freshly mined metals and recycled metals; precious metal circularity is an indispensable part of a sustainable future.

Recycled precious metals have a potential 98% lower carbon footprint than newly mined ones. To fully exploit this, a wet chemical process can be used, which offers the lowest $CO_2$ footprint of the recycling processes for platinum group metals. Recycled metals based on a TÜV SÜD certified mass balance approach can also be purchased, which can help lower Scope 3 carbon footprints.

## Considering the total cost of ownership

The nitric acid industry needs flexible answers to run plants according to quick-changing market requirements, such as

volatile raw material prices, as well as tighter environmental targets.

Heraeus Precious Metals focuses its activities on providing products and services for the nitric acid industry. The company's gauze catalysts are based on varying physical parameters and metal alloys in different gauze layers. Each gauze catalyst design has to be tailored to the operating conditions of the specific plant and customer requirements. The gauze catalyst concept not only takes into account the plant operation conditions, but also the cost factors from the market conditions to provide the gauze catalyst design with the best economic benefits for nitric acid plants.

**Figure 1.** Prepared fine powder for the final sampling stage (Source: Heraeus Precious Metals).

**Figure 2.** Representative sample splitting for PGM assay (Source: Heraeus Precious Metals).

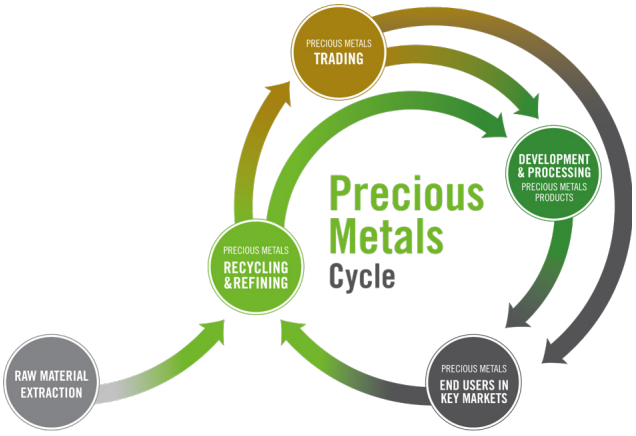



**Figure 3.** The combined expertise of trading, products and recycling keep valuable customer assets in a closed loop, lowering total cost of ownership and $CO_2$ footprint.

## Catalyst refiners

The recycling of precious metals is an important area for Heraeus, and the company is reflecting this by running a global investment programme.

In the recycling processes, the precious metals are recovered by pyro- and/or hydrometallurgical processes down to the atomic level, to metals with at least 99.90% purity.

In addition to the recovery rate, other important criteria for the selection of a refining partner are transparent and auditable processes, sufficient capacities, and the ability to provide the precious metals in the region where they will be needed after refining. The cross-border transport of waste containing precious metals presents its own challenges due to environmental regulations and customs requirements. Capacities are also important because the partner must be able to supply the replacement quantities of precious metals reliably and in line with market requirements, whilst meeting compliance criteria and the necessary certification.

In the fertilizer industry, platinum, palladium and rhodium are utilised most often. The following deep dive into precious metals recovery will focus on the platinum group metals, which are needed most in the fertilizer industry.

These three platinum group metals (PGMs) originate from and remain mainly in the gauze layers applied in the ammonia oxidation process, but, through side reactions with the reaction medium, will volatilise to some extent. The PGMs deposit again at cooler spots downstream of the gauzes, for example on heat exchangers or piping side walls. From there, they will end up in sludges and residues once plant cleaning is undertaken. It is highly dependent on the plant's operating parameters, as well as the cleaning technique applied, how much of the PGMs will be found in the plant cleaning sludge, and what content in weight-percentage (w%) they represent in the accumulated material.

The recovery of these PGMs is, of course, desirable, but also needs to be economically feasible for their owner. In other words, the costs for the recycling overall should not exceed the value of the recovered and returned PGMs.

Heraeus evaluates samples from such materials through various analysis methods, ranging from PGM content analyses from a few hundred ppm to high w%, to full component analyses. The data will not only help evaluate the economic feasibility of a refining job, but will also help in declaring a full composition and developing a classification for fulfilling all transport regulations (waste regulations, dangerous goods legislation, etc.). The company also has expertise in these legislations and can support with all documentation regarding notifications for international hazardous waste transports.

Once received, a full refining order of any material will be prepared, sampled and assayed, to determine the exact PGM content of any one delivery upfront before any actual PGM recovery takes place. A guaranteed return of a certain

percentage of the PGM amount determined will be credited back to the customer for further use after the recycling process is finished. It is, therefore, imperative that this value determination is as precise and accurate as possible, given the high value of the content to be recovered. The risk of loss of value both for the recycler and the customer needs to be mitigated to the highest degree. The company therefore employs a 100% sampling of all incoming materials after as-few-as-possible necessary preparation and processing steps are taken and uses only new equipment and processes according to sampling theory and good sampling practice.

As one example, sludges from plant cleaning would, after a thermal preparation to dry the material, be milled to a particle size significantly below 1 mm. The thermal preparation is performed with minimal-to-no disturbances and in chamber furnaces with off-gas emission abatement systems, ensuring environmental conformity. The milled fine powder, after a period of vigorous blending, will be passed through a representative sample splitter, taking at least 30 - 100 increments over the complete material stream to arrive at a combined raw sample of 2 - 5 kg.
After determining the loss on drying of this material, to correct for a stable mass basis, the raw sample is further milled to <200 µm and split into up to eight samples for assays (Figures 1 and 2).

The assay methods remain precise, accurate and up to par with and above industry standards. Only developed and validated analysis methods with high precision, including ICP-OES spectrometry after representative aliquot splitting, full dissolution, dilution by mass and measurement including bracketing methods against standards, are employed. Heraeus regularly measures its analytical performance against standard materials and takes part in round robin analysis studies. The company also continuously invests in new equipment and in optimisation of these vital process steps.

In most cases, the sampling process can be witnessed, either by the customer themselves or by a certified supervision company in their name. Transparency is welcomed, as is a four eyes principle to create long-lasting trust with customers.

Only after the sampling process has been performed, the material will enter the actual recovery and refining processes. In these processes, the material can now be combined with other streams of similar materials coming in, to ensure that capacities are fully employed and the cost-saving effect of an economy of scale is felt. The company's processes, though elaborate, are robust against the plethora of incoming materials to be processed.

## Resilience in an ever-changing market environment

The procurement strategy of many companies is aimed to make their supply chains more robust. Nevertheless, care should be taken to ensure that suppliers can cover the whole precious metal cycle of procurement, use and recovery (Figure 3). WF

## Reference

1. www.lppm.com/good-delivery