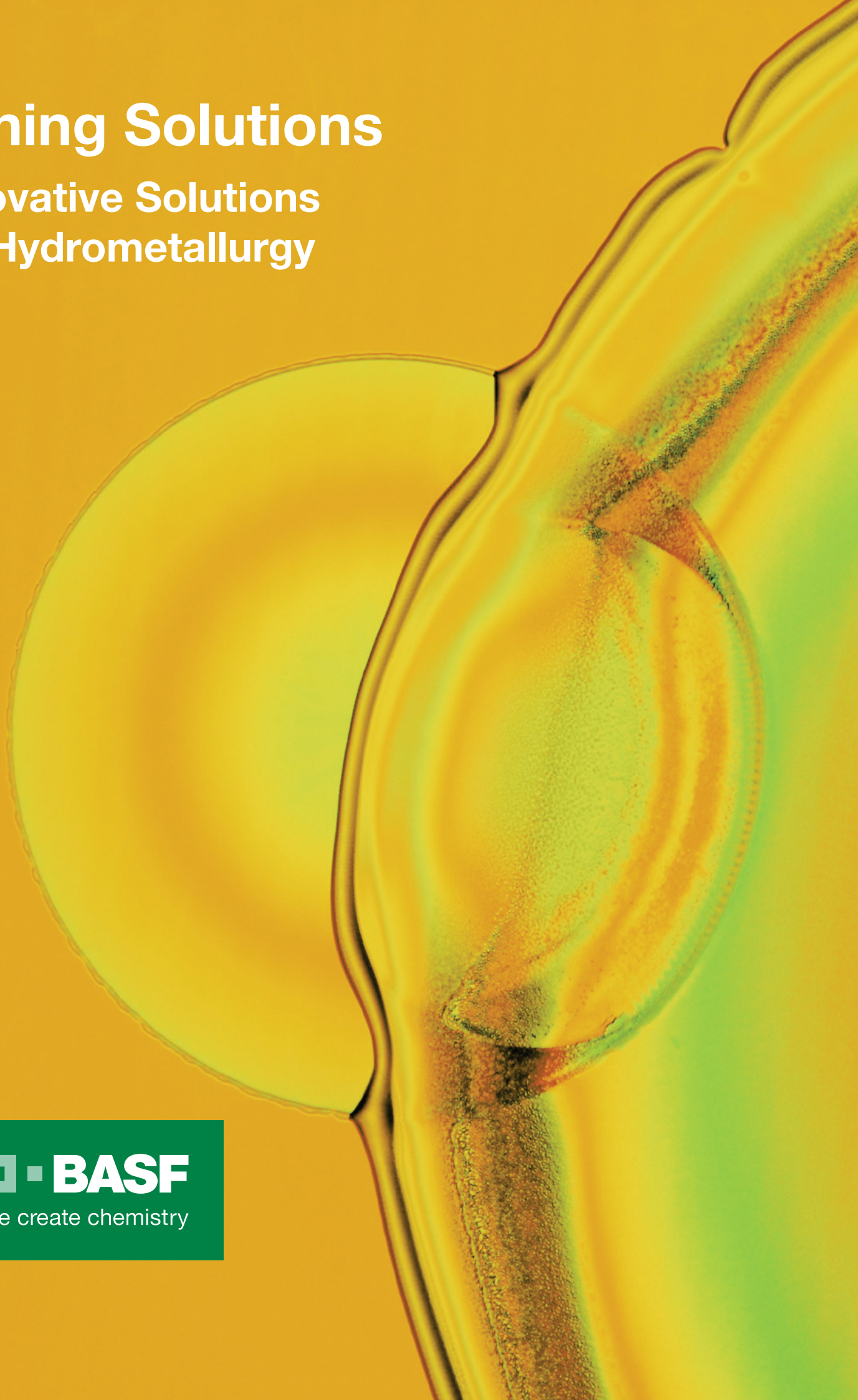
# Mining Solutions

## Innovative Solutions for Hydrometallurgy



BASF

We create chemistry

# BASF's Mining Solutions at a glance

BASF's Mining Solutions business offers a diverse range of mineral processing chemicals and technologies to improve process efficiencies and aid the economic extraction of valuable resources.

We offer our products and technology solutions to the global mineral processing industry along with expert advice and technical support. Our global team is driven by a common goal to provide the best sustainable solution to meet our customers' processing needs. With technical representation in over 100 countries, BASF's technical support is provided on a global, regional and local basis.

Our chemical and process expertise includes reagents, equipment, process technologies and know-how. All of which are focused on hydrometallurgy, solid liquid separation, tailings management, materials handling, flotation and grinding.

BASF's hydrometallurgical offering includes solvent extractants, purification clays, antiscalants and descalants.

# We offer solutions for the solvent extraction of metals

## Copper

### LIX® range of solvent extraction reagents

BASF has an extensive range of copper selective hydroxyoxime solvent extractants.

- Ketoxime – Moderate strength extractant, easily stripped providing high net transfer
- Modified aldoximes – Strong extractants that require use of modifier to tailor stripping behavior to meet customer process or application requirements
- Aldoxime/Ketoxime blends – Formulation properties can be tailored to meet individual customer process requirements

### Benefits include

- High selectivity for copper over other metals (e.g. Fe, Co, Ni, As, Mn)
- Broad operating parameters (low and high grade ores as well as arsenic-containing ores)
- Production of high grade copper cathode

### Lupromin® F-20X

Purification clay F20X is used to remove surface active compounds from in-process copper SX organic solutions.

### Benefits include

- Improved extraction and strip kinetics
- Reduced phase separation times
- Reduced entrainment
- Reduced impurity transfer to the electrolyte (e.g. Fe, Cl, Mn & NO3)

### LixTRA™ Heap Leach Aid

LixTRA™ Heap Leach Technology is in the final stage of development with the goal to offer the industry its first leaching additive that is compatible with the entire Leach->SX->EW process. The addition of LixTRA™ is intended to not only significantly increase copper recovery, but also increase the rate of copper recovery when compared to a control. LixTRA™ will therefore potentially offer the following benefits to a mine:

- Increases rate of copper leaching
- Reduces operating costs per ton of cathode; increasing profitability
- Opportunity to mine less ore to achieve the same production quota, reducing mining costs
- Extends life of mine, increasing return on investment

## Nickel / Cobalt

### LIX® range of solvent extractants

LIX® 84-ICNS (2-hydroxy-5-nonyl acetophenone oxime formulation) is used as a nickel extractant from ammonia leach solutions.

**Benefits include**

- Very efficient Ni extraction and recovery
- Production of high-purity Ni cathode
- Easy cobalt precipitation from nickel-free leach solution

## Uranium

### Alamine® range of solvent extractants

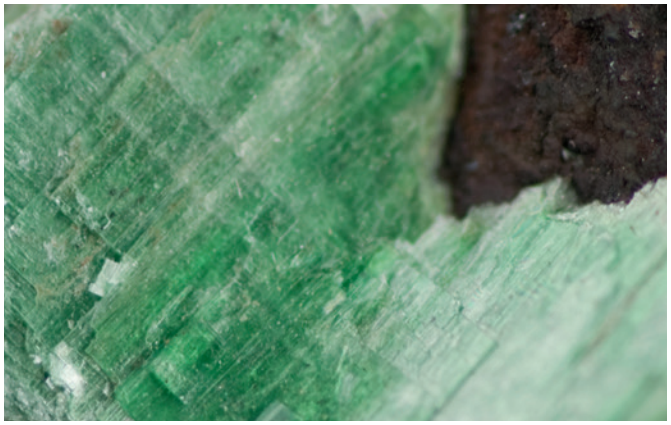
Uranium solvent extraction is accomplished using Alamine® 336 (a mixed C8/C10 tertiary amine) and an alcohol solvation modifier in a kerosene dilutent.

**Benefits include**

- Selectivity for uranium over other metals and minerals (e. g. vanadium, molybdenum, zirconia, cobalt and gold)
- Proven technology, used for over 50 years

### Additional Extraction Chemistry

| | |
|---|---|
| Cobalt | Cobalt extraction from chloride leach solutions using Alamine® 308 |
| Vanadium | Vanadium extraction using Alamine® 336 |
| Platinum | Platinum separation from PGMs using Alamine® 336 and Aliquat® 336 TG |
| Palladium | Palladium separation from PGMs using LIX® 84-A |
| Molybdenum | Molybdenum extraction using Alamine® 304-1 |
| Germanium | Germanium solvent extraction using LIX® 63 |
| Rhenium | Rhenium solvent extraction using Aliquat® 336 TG or Alamine® reagents |



# Antiscalants and Descalants

Scale is a common problem in mining operations. Scale formation in pipelines, tanks, heat exchangers, pumps and sprayers results in reduced flows, increased energy costs, decreased heating or cooling efficiency and costly downtime for cleaning and scale removal.

While scale formation can often be greatly reduced (depending on the system chemistry) by the appropriate use of BASF Solutrix™ antiscalants, (Solutrix™ 11, 11(J) and 100) sooner or later there is nearly always a need to remove existing scale.

Some scale minerals are amenable to acid cleaning and traditional strong mineral acids and weak organic acids have been used for this purpose for many years. Solutrix™ E is a product well suited to this application as it is a strong acid, dissociating completely for faster results than other organic acids, whilst being less corrosive and safer to handle than traditional mineral acids. Solutrix™ E has a primary area of application is the safe, efficient removal of scale from pipelines with minimal corrosion of the pipeline itself. There may also be additional areas of application such as descaling pumps, heat exchangers, tanks and mixers subject to appropriate safety procedures.

# Technical service: a global presence

We provide a wide range of technical support to our customers through our global network of experts and dedicated laboratories. Our global MSP® Minesite Service Program is a comprehensive, multi-component support service program that can be tailored to meet the specific needs of the customer. MSP® elements include:



## Expert consultation for process and flowsheet optimization

BASF experts provide technical support, performance evaluations and recommendations. Our IsocalcTM and OptiformTM software is used to evaluate alternative process scenarios and define improved plant flow sheets and is used as a basis for developing site expansions.

## Process modeling and simulations

BASF engineers can help define and optimize your plant operations by using computer simulation studies as well as lab scale and pilot plant trials of various circuit configurations and operating conditions.

## Reagent evaluation for optimum performance

We work with our customers to define the optimum reagent type for their operation. We focus on increasing production and reagent performance to improve product quality and lower costs.

## On-site support, start-up assistance and pilot plant evaluations

MSP® engineers may be assigned to a mine site full or part-time over a specific period to meet the needs of the customer. A key ingredient of the MSP® is training of plant personnel. We provide pre-start-up operator training, laboratory set-up assistance and on-site analytical training at customer sites. BASF partners with customers to troubleshoot problems to ensure a smooth start-up and solve any problems quickly. We use pilot plant evaluations to optimize the performance of our reagents to improve process efficiency. BASF also works with its customers to develop specific training courses for their engineers and plant operators that relate to their plant operations.

## Metallurgical profiles and process monitoring

Metallurgical audits encompass detailed benchmarking of equipment, site operating parameters and process bottlenecks. Audits of this kind can determine the root cause of a problem and provide comprehensive recommendations or “best practices”.


# Benefit from BASF's research and development capabilities

Innovation is at the heart of BASF's Mining Solutions vision. Our aim is to develop novel and innovative chemistries and technologies to meet the challenges the mining industry continues to face. In order to further our understanding, BASF is committed to working in close collaboration with our customers, academia and global industry organizations.

BASF's extensive backward integration into the building blocks of mineral processing product chemistries enables us to effectively apply our knowledge and chemical experience to develop both conventional and novel chemistries to meet the technical and commercial challenges faced by the industry today.

Our Product Development and Technical Support personnel are located around the globe and are complemented by three Global Competence Centers based in Tucson (US), Ludwigshafen (Germany) and Perth (Australia).

# Responsible Care and Sustainability

The Mining Solutions group has won several environmental awards over the years, including World Mining Magazine's environmental award and the coveted European Better Environment Award.

Our products and processes are part of BASF's Responsible Care initiative, which is designed to promote the careful use of the world's resources so that we can harvest the metals we need while protecting and preserving the environment.

BASF is the world's leading chemical company and aims to strengthen this position. BASF's goal is to "Create chemistry for a sustainable future". Sustainable development combines economic success, social responsibility and environmental protection.

**Facing the world's growing population and limited resources, we see three major areas in which innovations based on our chemistry will play a key role:**

- Resources environment and climate
- Food and nutrition
- Quality of life

To maximize our potential in these three areas as one company, we will enhance the long-term success of our customers and our company by fostering R&D and innovation in more sustainable products and solutions. Therefore, one of our four strategic principles is "We drive sustainable solutions". We will firmly integrate sustainability in our day-to-day activities because our position as the world's leading chemical company opens up unique opportunities to contribute to a more sustainable future for societies.

**Our management has three strategic responsibilities with regard to sustainability:**

- Minimizing risks
- Establishing strong relationships with our internal and external stakeholders
- Taking advantage of business opportunities

BASF enlists internal and external experts to identify, analyze and assess sustainability topics. The focus of our sustainability management revolves around product safety, climate and energy, water, human and labor rights, human capital development, biodiversity, renewable resources and sustainable products.

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