SUSTAINABLE MICA: SYNTHETIC VS NATURAL

An evaluation of environmental impacts via the
Life Cycle Assessments (LCA) methodology
Completed by thinkstepAG on behalf of BASF Colors & Effects

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EFFECT PIGMENTS

Most effect pigments are created by coating a substrate in metal oxides to create a range of colors and effects

- Natural mica, a mined mineral, is one of the most commonly used substrate for effect pigment production
- Synthetic mica, a chemically processed substrate, was introduced in the early 2000s
- Other popular substrates include: borosilicate and aluminum
- Effect pigments service a range of industries including: Coatings, Cosmetics, Printing, Plastics, and more

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THE BCE TOOLBOX APPROACH: DIFFERENT TECHNOLOGIES MEET DIFFERENT NEEDS

Natural Mica

- The widest array of colors and effects in our portfolio
- Backward integrated for a secure supply of natural mica
- Eligible for natural and sustainable certifications

Synthetic Mica

- Whiter substrate for cleaner color
- Lower trace metals
- No restrictions on size

Borosilicate

- High sparkle effects
- Smooth surface area for clean, high chroma, and color variable effects
- Eligible for natural certifications

Bismuth Oxychloride

- Unique white color additive, globally approved
- Softest texture, excellent skin adhesion
- Very low trace metals

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defining an effect pigment, traditional substrates, and key industries

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leading consumer trends supporting the growth and importance of sustainability across industries

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an overview of the Life Cycle Assessment methodology and the elements covered within the study

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Digging into Mica
compare the processes to achieve a natural and synthetic mica substrate

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a summary and deep dive into the results of the LCA study comparing natural and synthetic mica

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Clean Mica
explore the mining practices and processes utilized at BCE to produce sustainable and ethical natural mica for effect pigment production

SUSTAINABILITY GOES MAINSTREAM

Purchasing with Purpose

Buying for change:

61% of Consumers are worried about climate change, and more than half feel they can make a difference based on their own purchasing decisions

From vegan products to electric cars, consumers use their purchasing power to make change

Rise of Natural

Natural is safe:

Millennials and Gen Z are driving the growth of natural, motivated by the increased awareness of harmful effects associated with synthetic chemicals

Natural cosmetics is expected to grow 5% yoy thru 2025, reaching over 40 Billion USD

Trust thru Transparency

A focus on sourcing:

Tracking ingredients to the source, fair trade labels, and local sourcing create transparency for consumers

From automotive to beauty to food, key players across industries are starting to introduce block chain, allowing consumers to track ingredient sources with their smart phones

The Re-Movement

Quality over quantity:

Reuse, recycle, repair, repurpose- the life of a product is a growing influence among buying decisions

This puts the sustainability topic into the hands of the entire value chain- from raw materials to manufacturers to retailers to consumers

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LIFE CYCLE ASSESSMENT (LCA) OVERVIEW

aka: life cycle analysis, ecobalance, cradle-to-grave analysis

A technique to assess environmental impacts associated with all stages of the product's life- from raw materials, to manufacturing, to sales and distribution.

LED BY

3rd party evaluation:

thinkstep AG, with cooperation from BASF Corporate Sustainability and BASF Colors & Effects

SCOPE

cradle-to-gate:

the preparation of a mica substrate for effect pigment production- comparing the impacts of mining to synthetic production; excludes use and disposal phase

INPUTS

natural mica: data provided by BASF based on own mining practices

synthetic mica: primary data from BASF suppliers, complemented with secondary data and internal expert knowledge

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LCA METHOD: ENVIRONMENTAL FACTORS

eutrophication- freshwater

eutrophication- marine

acidification of water and ground

resource depletion- minerals and metals

human toxicity potential
Based on BASF Tox Points

climate change

photochemical ozone creation

resource depletion- fossil

LCA METHOD: NORMALIZING IMPACT

person-time concept

$$\frac{\text{Total society impact per year of } CO_2 \text{ emission}}{\text{population}} = \text{Per person, per year impact}$$

*based on CO2 emissions and population of Europe

example: a product results in 1000 kg CO2 emissions

505 million people

One person's impact is:
9.1 t CO2 emissions per year
(1000 kg CO2e/
9100kg CO2e per person per year)

Total impact of a society per year:
4.6e12 kg CO2 Emission

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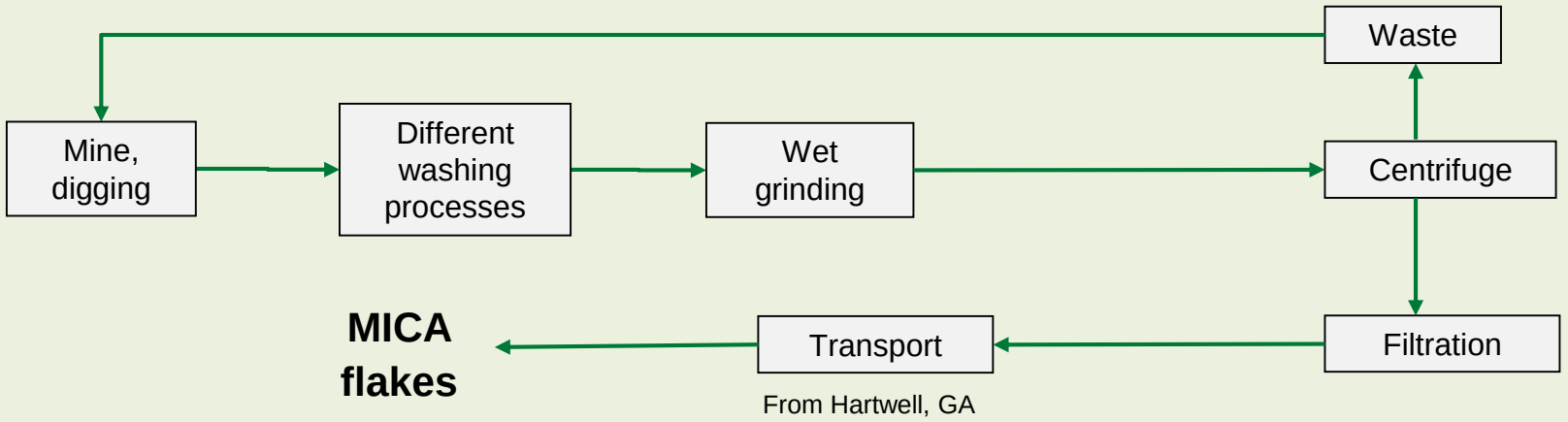
DIGGING INTO MICA: NATURAL VS. SYNTHETIC PROCESS



- BASF Colors and Effect's mining process- Hartwell, GA, USA:
  - Resources needed: water, electricity, natural gas, and minerals
  - Chemical free processing
  - Use of recycled water during the mining and filtration process
- Natural mica is mined and processed in Hartwell, GA, then transferred to North Charleston (used as study benchmark) or Peekskill, NY.
  - Effect pigment production resides among the East Coat of the US to minimize transportation impacts and maximize control of the supply chain

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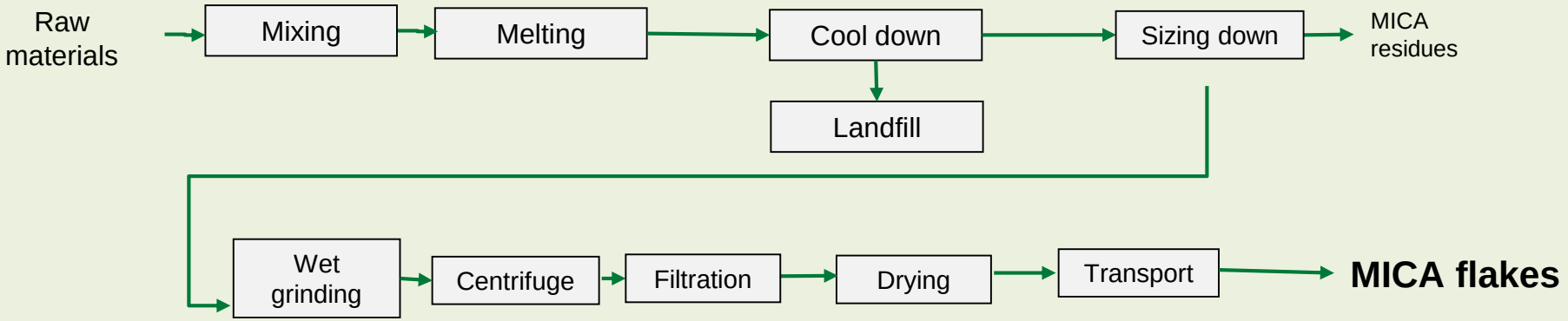
DIGGING INTO MICA: NATURAL VS. SYNTHETIC PROCESS



- Majority of synthetic mica production is located in China
- Resources needed: water, electricity, natural gas, and minerals
- Created using a chemical process derived from collection of elements, some of which are also mined

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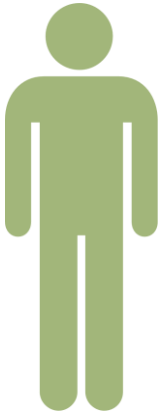
LCA RESULTS

The production of synthetic mica has **6.5X** the environmental impact of mining and processing natural mica

SYNTHETIC

VS

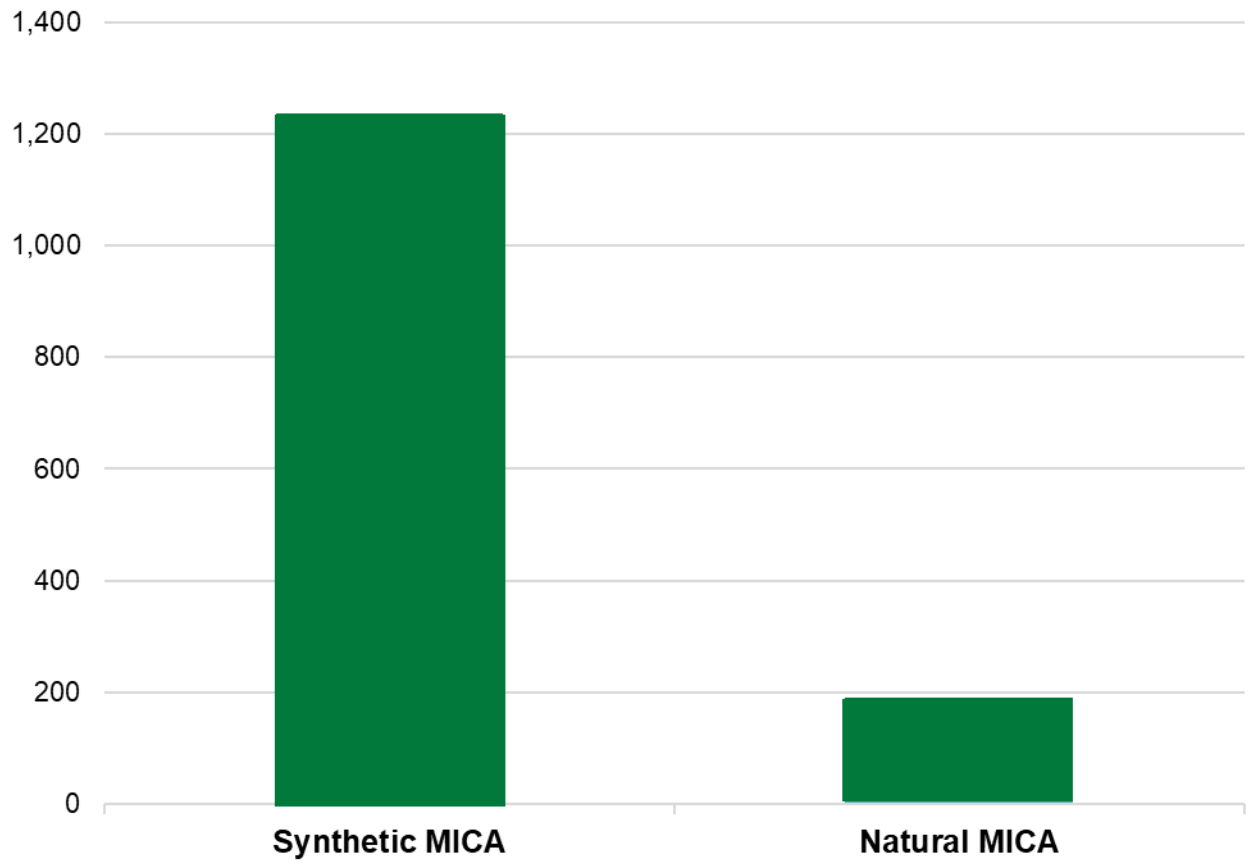
NATURAL



LCA RESULTS: SUMMARY

EEA 6, BASF Normalization - Environmental impact (person years, GLO, 2018)

Climate change
Resource depletion- fossil
Resource depletion- minerals and metals
Acidification
Photochemical ozone creation
Human toxicity potential
Eutrophication- marine
Eutrophication- freshwater



The production of synthetic mica has **6.5X** the environmental impact of mining for natural mica

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CLEAN MICA

~60% of the world's mica is sourced in India; mined in socially and economically challenged regions, with a high incidence of child labor, corruption in the supply chain, and poor working conditions

There is a clean side of natural mica, sourced from our wholly owned mine in Hartwell, GA, USA

- **Ethical** working practices
- **Environmentally conscious** mining methods
- **Traceable** supply chain

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CLEAN MICA
ETHICAL WORKING PRACTICES

FAIR & PROSPEROUS WORKING ENVIRONMENT

- Zero tolerance of discrimination at the workplace.
- Vacancies are filled taking all aspects of diversity into consideration.
- More than a job, BASF offers careers focusing on personal and professional development

BEST IN CLASS SAFETY

- Regulated and audited by MSHA, a federal agency in the Department of Labor
- Hartwell is compliant with 30 CFR* safety standards and is regulated under MSHA** part 48.
- Semi annual unannounced inspections cover physical plant conditions, mining areas, mobile equipment, industrial hygiene, and training records.

CONTINUOUS EDUCATION

- New miners are required to have 24 hours of training, as well as site orientation and must also be certified on all mobile equipment.
- Experienced miners are required to have 8 hours of MSHA refresher training each year, and uphold their mobile equipment certifications.

* Code of Federal Regulations, ** Mine Safety and Health Administration

CLEAN MICA
ENVIRONMENTALLY CONSCIOUS MINING

RECYCLED WATER

- Natural lakes on the Hartwell property provide water for processing mica
- Used water is returned to the lakes without harming the environment
- No chemicals are used during mica mining and processing

REFORESTATION

- Mining is done in sections, once complete it is filled in and restored to is original condition
- Freely accessible areas provide recreational space for local residents

ZERO WASTED MICA

- Separated clay, sand, and unusable mica is returned to the ground after processing
- Mined mica is sorted for use in specific industries/ applications
- Continuous improvement methods help us get the most of the mica mined

CLEAN MICA TRACEABLE SUPPLY CHAIN

CUSTOMERS WELCOME

- Guided tours and customer audits are available upon request

MATERIAL TRACKING

- All mica batches are trackable, labeled with the batch number, source date, and shipping address
- Mined mica is used for internal production of effect pigments and other products

VALUE CHAIN CONTROL

- From mining to coating, the production process of natural mica effect pigments is owned and controlled by BASF Colors & Effects

CLEAN MICA:
FROM SOURCING TO DELIVERY

1. The mica ore is excavated and stored for processing.
2. It is separated from clay and sand.
3. After washing and grinding, the mica powder is divided into batches and issued a tracking code.
4. Then it is processed into effect pigments at one of our sites in Peekskill or North Charleston.
5. Unused material and water is returned to the environment, providing new habitat for animals

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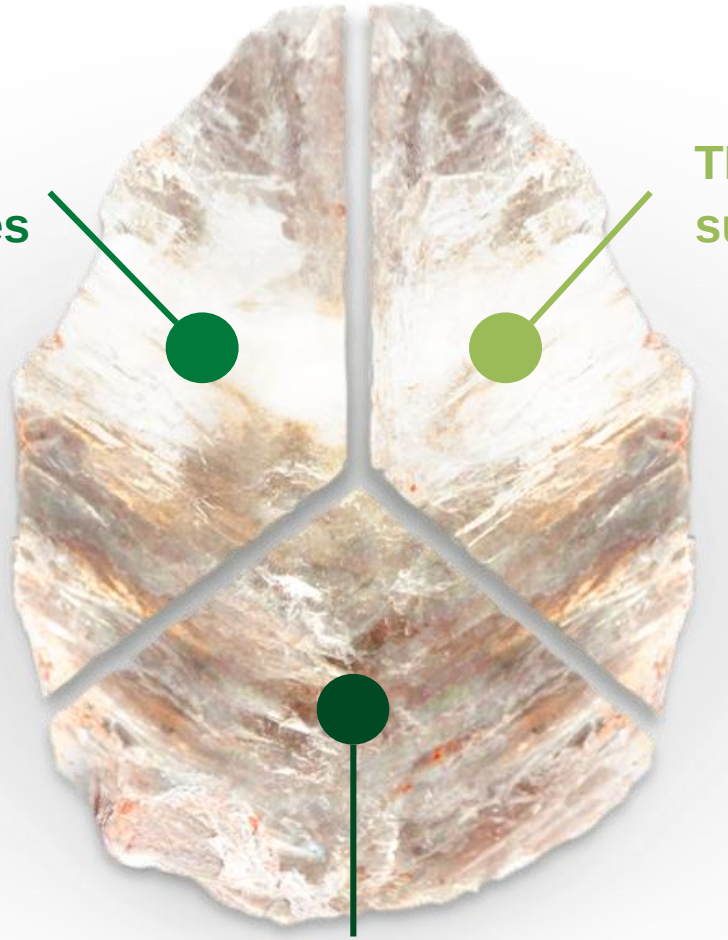
CLEAN MICA
EACH FLAKE CONTAINS 3 PRINICPALS

ETHICAL
working practices

TRACEABLE
supply chain



ENVIRONMENTALLY
conscious mining

EXPLORE OUR NATURAL MICA BASED EFFECT PIGMENTS

Find your perfect pigment with Pigment Finder

Filter. Find. Formulate.

> Visit Pigment Finder

pigment-finder.basf.com

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