

NANO-INDIS™

**UNIQUE WITH THE MOST
DESIRED PROPERTIES**

**A FAMILY OF
“DREAM INDICATORS”**

UNIQUENESS OF NANO-INDIS

(Indicators)

- The thickness of the indicator layer is incredibly ultra thin, only ~10 nm and still highly opaque
- The indicator is a metal, usually aluminum (which is non-toxic and its salts are also non-toxic)
- Metallized plastic films having different thicknesses of aluminum layer (~2 – 70 nm) and different colors are readily available. Hence, no need to make the indicator tape

UNIQUENESS OF NANO-INDIS

(Indicators)

- Even 10 nm thick layer of aluminum provides 99% opacity. About ~2 nm aluminum layer is semi transparent.
- Average visual accuracy of the devices is about 80% but can be as much as 99%
- The change is from opaque and reflective/shiny to transparent. Shiny/reflective surface is easily noticeable

UNIQUENESS OF NANO-INDIS

(Indicators)

- Metallized inks are readily available. Commercially available aluminum (called silver) and bronze (an alloy of copper and zinc called gold) inks can be used instead of metallized plastic films
- A number of metals and a large number of their alloys having different sensitivities to different activators can be used to make a variety of indicators and monitoring processes using materials having different properties

UNIQUENESS OF NANO-INDIS

(Activators)

- Reactions can be carried out with common nontoxic materials such as water, oxygen, acids, bases and salts
- A large number of activators and precursors for activators can be used to develop a variety of indicators
- Activator tapes are made by coating a pressure sensitive adhesive (PSA) containing an activator. PSA tape technology is a well developed technology.

UNIQUENESS OF NANO-INDIS

(Reaction)

- An oxidation/corrosion of a metal is one of the simplest and well understood reaction
- The reaction is 100% irreversible
- The reaction is heterogeneous. It occurs only on the surface of the metal and hence gives zero order kinetics, i.e., linear with time, which is one of the most desired properties. This also makes the devices highly accurate.
- The reaction for almost all non-nano indicators is usually the first order/asymptotic, i.e., fast in the beginning and slows down with time

UNIQUENESS OF NANO-INDIS

(Reaction)

- Reaction products are usually colorless, white salts (when metals such as Al and Zn are used)
- Being super ultra thin layer, even opaque reaction products, e.g., aluminum oxide are essentially nearly transparent
- Even though the reaction occurs at a steady rate, opaque layer becomes almost transparent only when $\sim 1 - 2$ nm layer is left. The oxide layer provides a very long induction period which is most desired for go/no-go type indicators

UNIQUENESS OF NANO-INDIS

(Colors and message)

- Typically, a non-nano indicator undergoes a color change. Nano-Indis are based on change in transparencies
- Change in transparency makes it possible to print any message or color under the metal layer, i.e., unlimited final colors/messages

UNIQUENESS OF NANO-INDIS

(Double-message)

- By printing a part of a message (e.g., “GOOD”) over the metal layer and another under the metal layer (e.g., “NOT”), it is possible to create two messages (GOOD → NOT GOOD, NOT STERILIZED → STERILIZED)
- It is also possible to create moving boundary devices for continuous monitoring of a process or a material
- That makes Nano Indis self reading, accurate and idiot proof

UNIQUENESS OF NANO-INDIS

(RFID)

- Conductive circuit paths (electronic circuits) can be destroyed and can be created
- RFID type devices can be created for monitoring a variety of materials and processes
- Both readable → no readable and vice versa type RFIDs can be created

UNIQUE/DREAM INDICATORS

- The combination of all these and many other desired properties, makes the Nano-Indis unique among the unique
- They are literally “dream indicators”

NANO-INDIS™

**A REVOLUTION IN
INDICATOR TECHNOLOGY**

**UNIVERSALIZING &
REVOLUTIONIZING
THE INDICATOR TECHNOLOGY**

NANO-CONVERSION TECHNOLOGY

AN IGNORED BUT NOVEL AND
UNIQUE FIELD OF NANOSCIENCE

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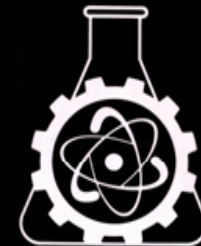
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Nano-Conversion
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