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MMM technology in ultrasonic treatment of high-tech parts, sensitive and complex metal parts, treating of biological implants, surgery, vibrothermography, deep sterilizing...

1. **Stress relief** by vibrating the complete part, artificial **accelerated aging** and fast properties stabilization.
2. **Extending life-span** of treaded parts (longer operating life, longer fatigue life).
3. **Surface treatment** under MMM vibrations: **sand blasting**, chemical **etching**, surface chemical modification, deep cleaning enabling capillary penetration of a cleaning liquid, **ball peening** under MMM-vibrations and deep **implementation of different particles and powders** in a treated metal surface.
4. **Vibrothermography**: By uniformly vibrating certain body (using MMM vibrations), and monitoring transitional heat generation on its surface (using infrared cameras), **one can notice in the areas with voids, holes, residual-stress zones, or other defects, non-uniform and increased temperature distribution.**
5. Stress-free **quenching and hardening** assisted by multifrequency vibrations (also hardening applying **ball peening**).
6. Improved **coating** of metal parts under vibrations: by immersion in coating liquid and/or by dry ball-peening in MMM ultrasonic chamber. Deeper coating and **particles implementation** realized ultrasonically. Accelerated stabilization of coating layer.
7. **Welds treating** by ultrasonically vibrating the parts: **extending fatigue life** of welds several times (3 to 5 times). Redistributing and minimizing stress concentration caused by welding.
8. Accelerated **free radicals de-excitation** and neutralization in cases of treating plastics and composites (applicable also in cases of coating).
9. Vibrations accelerated **polymerization** (or de-polymerization in case of applying very strong vibrations).
10. Ultrasonically assisted **degassing and de-bubbling**.
11. Ultrasonically **improved alloying and casting**. Production of homogenous biocompatible alloys.
12. Ultrasonically **facilitated implantation and/or penetration** of metal objects into biological and composite structures.
13. **Deep structural and capillary holes cleaning, sterilizing, and decontamination**: Surgery, implants, complex and holed solid structures.
14. MMM, **DRY Ultrasonic cleaning**.

**ACCELERATED TESTING and TREATMENT of
HI-TECH COMPONENTS AND PRODUCTS
Using HIGH-POWER ULTRASONICS**

High Power ultrasonics is offer a wide range of opportunities to assist in rapid testing and surface treatment of components and assembled systems. Some examples include:

- Accelerated 3-D Shock / Vibration test with Ultrasonic SHOT PEENING
- Accelerated Surface Treatment with Ultrasonic SHOOT PEENING
- Accelerated leakage and sealing test in liquid ULTRASONIC BATH
- Accelerated humidity resistance, corrosive resistance, or salt resistance using an ULTRASONIC VAPOR chamber

Applications: Hi-Tech, Watch-Industry, Microelectronics, Micromechanics, Military, Aerospace, Medical, Surgical Components and implants, etc.

All of above mentioned tests and treatments could be realized in a specially designed ultrasonically vibrating chamber (preliminary prototype available for presentation).

Accelerated 3-D Shock / Vibration test with Ultrasonic SHOT PEENING:

Small stainless steel balls in a specially designed ultrasonic chamber will be mechanically stimulated to impact parts placed in the chamber. The part is randomly and uniformly impacted in 3-dimensions by the steel balls with sufficient force to create a wide range of stresses. Some applications include

- Ultrasonically accelerated mechanical and structural stability testing (of Watches, Micro-systems and Hi-Tech components).
- Accelerated bolt unscrewing test (Watch industry, Micro-Systems).

For the companies involved in the production of high tech micro-electronic and micro-mechanic components and systems it would be valuable to have a testing tools that can give rapid answer about mechanical reliability. It is possible that such mechanical bombardment is able to simulate in just minutes of testing results equivalent to several weeks or months of testing using traditional testing methods.

This is particularly interesting in the R&D phase of new products when it is extremely profitable to have such accelerated testing possibilities. Immediate feedback about certain product elements would significantly impact future exploitation and product reliability. Normally products are given to specialized laboratories for testing for weeks or months of testing while the R&D team waits for positive or negative results. With accelerated testing important product and design improvements can be quickly analyzed and implemented to improve time to market and improve product reliability.

In one implementation the piece to be tested is hanging in the middle of ultrasonic chamber. Small metal balls (introduced in the same chamber) are randomly scattering and bouncing inside of the chamber, realizing uniform 3-D bombardment of the hanging solid piece (watch case, micro-mechanical system, high-tech component). A few minute of such treatment may correspond to more than a week of traditional 3-D vibration and shock testing.

Accelerated Surface Hardening and Stress Release Without Heating using Ultrasonic SHOOT PEENING:

The shot peening process is based on the effect of introducing compressive stresses in the surface of a metal part by controlled impinging with spherical particles. By this the resistance against fatigue will be increased and therefore also the life of a part. In the space and aircraft-industries the advantages of the shot peening process are already known: the increase of the fatigue-life of critical parts without weight increase. We propose to use a specially designed ultrasonic chamber where the treated part is randomly and uniformly impacted in 3-dimensions. Some applications include:

- Watch-Industry parts, Various Micromechanics, Military Parts, Aerospace Parts, Medical Parts, Surgical Components and Implants

Some of the known beneficial effects that can result due to high power peening treatment are:

1. Formation of a white layer up to 10 microns in depth with exceptional corrosion resistance, abrasion resistance, and lubricity.
2. Plastic deformation of the surface.
3. Elimination of tensile stress and the introduction of favorable compression stress up to 12 millimeters in depth.
4. Altering the surface finish resulting in a smoother surface and eliminating defects.
5. Improvement in endurance and corrosion resistance. Up to 250% and 400% respectively.

Shot peening is also used in applications where the effects of fatigue were caused by grinding, electrical discharge- and electrochemical-machining (EDM and ECM), electroplating, anodizing, thermal spraying and welding. It also can help increase resistance to fretting, galling, cavitation erosion, stress-corrosion cracking, intergranular corrosion and hydrogen-embrittlement.

Ultrasonically accelerated surface coating with multi-component powders:

Here again we also employ small stainless steel balls in a specially designed ultrasonic chamber that are mechanically stimulated to impact parts placed in the chamber. In this case we also include a powder substance that we wish to imbed into the surface of the treated part. The part is randomly and uniformly impacted in 3-dimensions by the steel balls and the powder with sufficient force to allow penetration of the powder into the surface of the part.

- Powders may include: Metal powders, Ceramic powders, Polymer powders, and combinations of such powders.
- Some applications include: Watch-Industry parts, Various Micromechanics, Military Parts, Aerospace Parts, Medical Parts, Surgical Components and Implants

Accelerated Leakage & Sealing Test in a Liquid ULTRASONIC BATH:

An ultrasonic chamber filled with water (or some other liquid) may be used for leak testing, sealing, and corrosion resistance tests on watchcases, high-tech components, or Microsystems.

Ultrasonically Accelerated Corrosive and Salt environment Resistance testing:

An ultrasonically agitated chamber filled with certain vapor may be used for increased humidity resistance testing, sealing, and corrosion resistance tests on watchcases, high-tech components, or Microsystems.

STRUCTURAL INFRARED IMAGING AND DEFECTS DIAGNOSTIC

Fast and easy detecting structural defects, voids, flaws, stress concentrations and similar imperfections in big objects or blocks of solid materials with complex geometry (such as engine heads, motor blocks etc.) can be realized using combination of infrared imaging techniques and, sonic and ultrasonic wideband mechanical excitation.

In practice, the ultrasonic converter should be strongly coupled to the solid object under testing; -producing wideband (MMM) sonic and ultrasonic excitation, making that complete volume of the solid object is uniformly (and structurally) agitated. Certain amount of vibrating energy would start producing internal thermal dissipation (heating the object under testing volumetrically and uniformly).

All internal defects, voids, flaws and non-uniform stress concentrations (inside of the object under testing) would create different thermal conductivity zones, making that internally dissipated heat would propagate being strongly dependent of internal-defects geometry. Using a real-time, fast-speed infrared recording equipment, internal heat distribution would become externally visible, making defects, voids and flaws easily detectable.

Resume: MMM technology in ultrasonic treatment of high-tech parts, sensitive and complex metal parts, treating of biological implants, surgery...:

Stress relief
Accelerated aging
Extending life-span
Surface treatment
Ultrasonic sand blasting
Ultrasonic chemical etching,
Ball peening
Implementation of different particles and powders
Ultrasonic quenching and hardening
Ultrasonic coating
Welds treating
Extending fatigue life
Accelerated free radicals neutralization
Polymerization
De-polymerization
Degassing and de-bubbling.
Improved alloying and casting
Production of homogenous biocompatible alloys.
Facilitated implantation and/or penetration
Deep cleaning applications.

MMM technology in different applications

MMM Tube Reactor for through-flow Sonochemistry

The Tube Reactor is the ideal solution for sonochemical reactions applied to a continuous flow of liquid.



Advantages of MMM Technology for Sonic & Ultrasonic Cleaning

MMM Technology gives high-intensity, uniform distribution of ultrasonic activity inside a cleaner tank - no dead zones, no standing waves, allowing a reduction in concentration of cleaning solvents, detergents and additives, plus faster cleaning compared to traditional cleaning technology

Ultrasonically Assisted Plastic Extrusion

MMM Technology applied to the extrusion of composite plastic materials - photos of equipment used



Cleaning in Supercritical, Liquid Carbon Dioxide

MMM Technology applied to an ultrasonic cleaning process using pressurized liquid carbon dioxide as the solvent



Accelerated ultrasonic testing of high-tech components and products

Using accelerated high-power ultrasonic testing, one minute of testing can be equivalent to several weeks or months of traditional tests.

Ultrasonically assisted powders production

Using very specialized ultrasonic atomizing systems, a very high flow rate of almost any liquid can be easily transformed into fine spray and dried (dehydrated) in line, eliminating drying, solidifying or cooling channels and creating very fine dry powder as the end-product.

Liquid waste materials incineration assisted by ultrasonic atomization

Very dirty and used lubricants, oils and greasy materials, charged with solid particles can be ultrasonically atomized and very efficiently incinerated.

Thermal treatment and Stress Release

Small solid parts can be successfully stress-relieved in a very high intensity ultrasonic chambers, offering benefits such as increased fatigue limits, reduced likelihood of cracking, artificial materials aging, increased dynamic load bearing capacity, improved corrosion resistance, stress relieving, increased weld strength, material cost reductions, increased operating and service life

Ultrasonic cleaning, degreasing, and polishing of drawn profiles, rods, bars and tubes

Traditional ultrasonic cleaning normally operates at between 10 and 30 Watts of radiated ultrasonic power per liter of cleaning liquid. Modern ultrasonic cleaning systems can increase this ultrasonic radiating power by 10 to 100 times, offering more efficient cleaning without using Perchlor and Trichlor.

Wire, tube and profile drawing

The drawing of wires, tubes and profiles can be enormously facilitated by ultrasonic vibrations. When high power ultrasonic transducer is attached to drawing tool, it accelerates the drawing process.

Continuous and Static Casting with Ultrasound

Ultrasound above the threshold of acoustic cavitation can be introduced into molten metal during the continuous casting process, offering grain modification, micro-crystallization, filtering and refining, degassing and de-foaming, mixing and homogenizing

More applications of MMM Ultrasonic Technology

Other applications of MMM ultrasonic technology, including: Elimination of material buildup, defrosting, boilers maintenance, Gas mixers, Spray mixers, Ultrasonic machining, surface drying, defoaming, surface drying, filtration, sieving / screening, Ultrasonic reactors and extractors, micro encapsulation

Wastewaters processing:

Wastewaters and dangerous liquids treatment, neutralization, sterilization, decolorization, mixing and homogenization (using in-line, high flow rate, MMM tubular reactors).

Liquid Atomizers:

Liquid atomizers, large quantity spray/mist units, humidifiers, coating systems.

MMM Induction Heating:

Multifrequency, wide-band induction heating, alloying, liquid metals processing, advanced casting... Such induction heating systems can be operated like any other, traditional induction heating, and/or in MMM multifrequency mode. Using MMM induction-heating mode we can introduce multifrequency, wide band spectrum of mechanical oscillations inside of a liquid metal during casting in order to improve the cast quality (by means of multifrequency magnetic field, without touching a liquid metal).

Metal Welding:

Advanced, stress-free metal welding (combined with multifrequency agitation).

Recuperation, Recovery, Recycling:

Accelerated precious (and other) metals recovery, recuperation, recycling (realized by high intensity MMM vibrations).

Elimination of material buildup, defrosting, boilers maintenance:

1. Stone and mineral layers elimination from boilers and reservoirs
2. Airframe ice protection
3. Automobile windshield ice protection
4. Ice buildup protection for marine vessels
5. Refrigerator and freezer frost removal
6. Aircraft Anti-Icing and Deicing Using
7. Removal of mussels and other ocean life from marine vessels
8. Elimination of material buildup in crucibles

Gas mixers:

For semiconductor industry, microelectronics, solar technology etc. Tubular, in-line, continuous-flow, high capacity and high flow rate.

Spray units:

For pharmaceutical technologies: Micro Spray, or micro atomizing units for fine powders production, for atomizing very small liquid samples without losses

(applicable for almost any density and any viscosity liquids). Tubular or cylindrical resonant chambers.

Ultrasonic machining:

MMM, ultrasonic transducer connected to metal or ceramic cutting tool. Benefits : higher speed of cutting, better surface finishing.

Ultrasonic surface drying:

Airborne ultrasonic radiation projectors.

Ultrasonic defoaming:

Non-contact, ultrasonic foam elimination from the liquid surface.

Ultrasonic Coating:

Surface coating with very fine layers realized by high capacity spray units.

Ultrasonic reactors:

Submersible, or externally driven, Tubular, Multifrequency Sonic and Ultrasonic Resonators. For Cleaning, Sonoreactors, Reactions Accelerating, Emulsifying, Homogenizing, making Suspensions, Degassing, Sonochemistry, Extractions, for treating liquid food products...

Micro encapsulation:

Pharmaceutical and food industry.

Extractors:

Multifrequency Reactors for fast organic and inorganic Extractions (for usual as well as extremely aggressive liquids). High capacity, in-line, for continuous flow.

Ultrasonic filtration:

Fine filtration, self-maintaining filters. In petrochemical industry, waste water treatments etc.

Sieving/Screening of Powders:

Multifrequency MMM systems are used in order to avoid formation of a standing waves structure.

Imaginable Applications:

MMM technology in Radar and Sonar, Applications.

MMM, Seismic Sources, detectors, analyzers.

Modulation of laser and high intensity light beams (material/s processing applications).

Applications related to Very High Intensity Electromagnetic field sources, where MMM generator is the source of oscillations (energy transfer, security systems...).