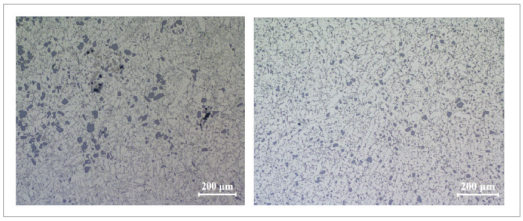
고출력 초음파용 랑지방 트랜스듀서 제조 기술

Design of Langevin transducer for high power ultrasound

TRL7

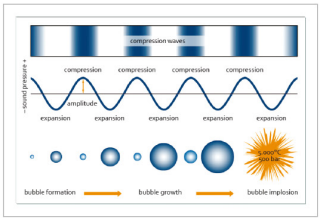
기술내용

- 고압/고출력 ultrasonic field를 발생시키기 위한 energy source
- 경량합금(Al, Mg 등)의 고강도화, bacteria 파괴에 따른 고도정수처리, 초음파절단/용접, 항공우주용 actuator 등에 적용



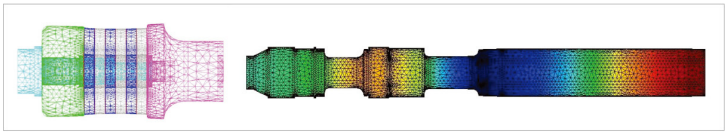
초음파 처리에 따른 Al합금의 입자 미세화

초음파 고도 정수처리

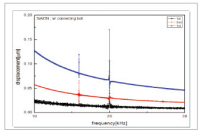


cavitation mechanism

- 유한요소를 사용한 BLT(Bolted Langevin Transducer), BLT의 변위를 증폭시키기 위한 booster 및 transmitter의 공진 해석
- 대역폭(bandwidth) 확대 및 mode-coupling 방지를 위한 booster/transmitter의 구조 해석 및 최적화
- 적용대상에 따른 공진(예; 초음파 고도정수처리) 및 반공진(예; 초음파 접합) 주파수/transmitter 구조 해석/제어



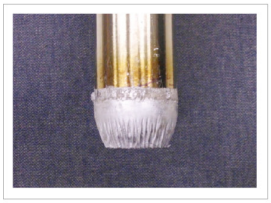
유한요소에 의한 BLT, booster 및 transmitter 공진 해석



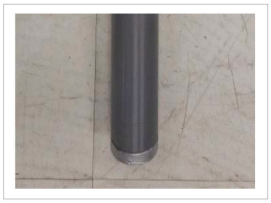
임펄스에 의한 transmitter의 공진 응답

우수성

- 고온/내부식(cavitation erosion-free) 성능을 가지는 세라믹계 transmitter의 설계/제조 기술
  - 기존 금속계 transmitter는 고온의 용탕 및 강한 부식성을 가지는 화학공정에 적용이 불가능함.



cavitation erosion
on metal tip



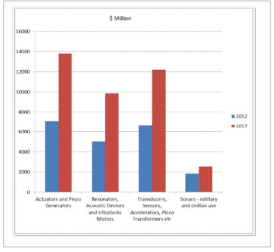
Erosion-free
ceramic tip

피스톤
초음파주조용 BLT

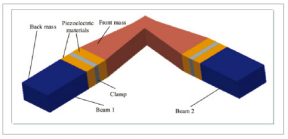
- 고정밀 공진 및 반공진 주파수 추적(1Hz 이내) 및 출력 제어 기술
- 적용대상에 적합한 공진주파수, booster의 진폭비 및 대역폭 등의 설계, 해석 및 제조기술

사업성

- 설계에 따라 다양한 진동모드를 가지는 BLT는 폭 넓은 적용처를 가짐
  - 우주/항공용 actuator, 고강도 경량합금 주조용 transducer
  - 수중탐상용 transducer, 초정밀 가공용 actuator
- 휘발유 및 디젤 엔진 피스톤의 초음파 주조(2017년 상용화 예정)
- BLT를 포함한 압전디바이스의 전세계 시장은 2017년 약 380억 달러로 추정됨(출처 iRAP Inc.)



압전디바이스의 시장규모



초정밀 가공용 초음파 모터

우주용 드릴

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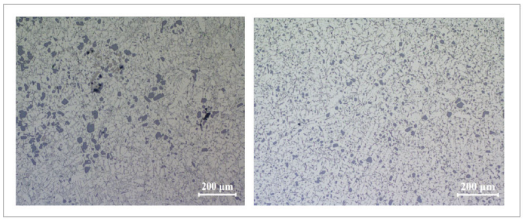
Design of Langevin Transducer for High-Power Ultrasound

TRL7

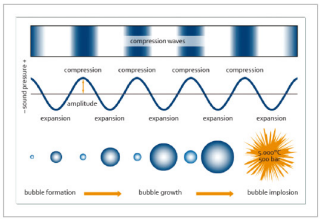
Technology Overview

- The source for generating high-power ultrasonic field
- Applicable to reinforcement of light-weight alloys (Al, Mg etc), advanced water purification, ultrasonic cutting/welding and actuators for the aerospace.



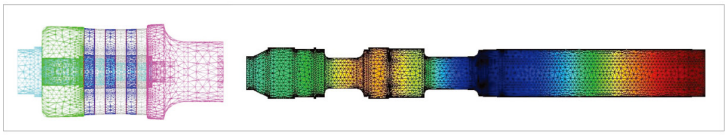
Refinement of Al alloy via high-power ultrasound

advanced purification using ultrasonic wave

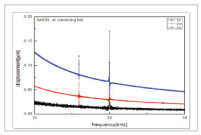


Cavitation mechanism

- Design and resonance analysis of the Bolted Langevin Transducer(BLT), booster and transmitter using Finite Element Method(FEM)
- Structural analysis and optimization of boosters and transmitters for widening bandwidth and preventing mode-coupling
- Resonance (i.e. ultrasonic water purification) and anti-resonance (i.e. ultrasonic bonding) frequencies control depending on an application fields



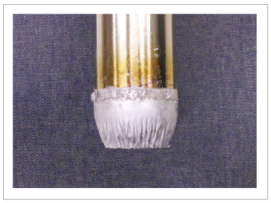
Resonance analysis of BLT, boosters and transmitters using finite elements



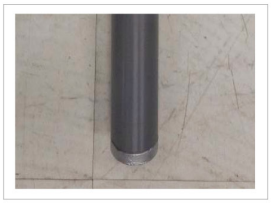
Resonance response from transmitter with impulse

Highlights and Strengths

- Design and fabrication techniques for the cavitation erosion-free transmitters based on high temperature ceramic materials
  - Ultrasonic treatment with metal-based transmitters are not applicable to high temperature metal processing as casting, and highly corrosive processes



Cavitation erosion on metal tip



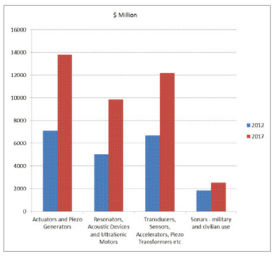
Erosion-free ceramic tip

BLT for ultrasonic casting of pistons

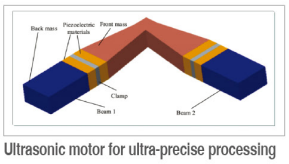
- High precision tracking techniques for resonance and anti-resonance frequencies(less than 1 Hz) with constant power management
- Design, analysis and fabrication techniques for the resonance of the BLT and for gain-ratio control of the booster with suitable bandwidth

Business Cases

- BLT having variable vibration modes depending on the design can be used for diverse application fields Including:
  - Aerospace actuators, transducers for light alloy treatment
  - Transducers for underwater navigation, actuators for high precision positioning
- Ultrasonic casting of piston, engine head for gasoline and diesel car
- The global market for piezoelectric devices including BLT is estimated at $38 billion in 2017 (source: iRAP Inc.)



Market size for piezoelectric devices



Ultrasonic motor for ultra-precise processing

Aerospace drill

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