Suppression of Crack Initiation of Metallic Materials by Using a Cavitating Jet

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Cavitating S Peening®
Shotless Shock wave Smooth surface SOYAMA

Shot Peening SP

Cavitation S Peening® CP

Intelligent Sensing of Materials Lab., Department of Nanomechanics, Tohoku University
“Cavitation Peening” and “Water Jet Peening”

Cavitation impacts

Droplet and/or shot impacts

In Water

High-pressure

Nozzle

Potential core

Droplets

Cavitation

Collapsing region

Developing region

Cavitation impacts

Cavitation Peening (Cavitation Shotless Peening)

Water Jet Peening

Water Jet Shot Peening

Schematic representation*


Intelligent Sensing of Materials Lab., Department of Nanomechanics, Tohoku University
“Cavitation Peening” and “Water Jet Peening”

In Water

Pressurized water

Cloud cavitation

Droplets

Surface

Vortex cavitation

Ring erosion

Collapsing region of vortex cavitation

Developing region of vortex cavitation

Collapsing region of vortex cavitation

Droplets impacts

Cavitation impacts

Potential core

Inverse of curvature \( 1/\rho \) m\(^{-1}\)

Normalized standoff distance \( s/d \)

Arc height

- \( p_1 = 30 \text{ MPa}, d = 2 \text{ mm} \)
- \( p_1 = 300 \text{ MPa}, d = 0.4 \text{ mm} \)


\( p_1 = 300 \text{ MPa} \)
**Cavitation Peening** and **“Water Jet Peening”**


\[
\frac{S_{\text{opt}}}{d} < 1.8 \sigma^{-0.6}
\]

**Water Jet Peening**

\[
\frac{S_{\text{opt}}}{d} \geq 1.8 \sigma^{-0.6}
\]

**Cavitation Peening**

Cavitation number: \( \sigma \)

\[
\sigma = \frac{p_2 - p_v}{p_1 - p_2} \approx \frac{p_2}{p_1}
\]

Injection pressure of the jet: \( p_1 \)

Downstream pressure of nozzle: \( p_2 \)

Vapor pressure: \( p_v \)
Improvement of fatigue strength of gear demonstrated using a power circulating type gear tester (Carburized SCM420H)

Improvement of Fatigue Strength of CVT Elements

Joint Project with TOYOTA

Improvement of fatigue strength of elements of steel belt for CVT


**Cavitation Peening**

**Improvement of fatigue strength of elements of steel belt for CVT**
Suppression of Hydrogen Embrittlement


- Suppression of crack growth by Cavitation S® Peening
- Hydrogen embrittlement
- Hydrogen charged
- Uncharged
- Unstable crack growth
- Not treated
- Stable crack growth
- Cavitation Peening
Thank you for your kind attentions