Cavitation S Peening®

S : Shotless, Shockwave, Smooth, Soyama

Cavitation S Peening® is a peening method using cavitation impacts in the same way as shot peening to improve fatigue strength and/or to introduce compressive residual stress. The peening method using cavitation impact is called "cavitation shotless peening (CSP)", as shots are not required (see Fig. 1). In the case of cavitation shotless peening, cavitation is generated by cavitation impact.

Cavitation is phase change phenomena from liquid-phase to gas-phase. It is similar to boiling, but, in the case of cavitation, liquid-phase becomes gas-phase by decrease of static pressure until saturated vapor pressure due to increase of flow velocity (see Fig. 2). When the static pressure is increased by decrease of the flow velocity, the cavitation bubble is collapsed. At the cavitation bubble collapse, a part of the bubble is deformed and a micro-jet is produced (see Fig. 3). As the speed of the micro-jet is about 1,500 m/s, the micro-jet produces plastic deformation pit on the solid surface. After the cavitation bubble shrinks, the cavitation bubble rebounds. At the rebound, shock wave is produced. The shock wave also produces plastic deformation (see Fig. 3).

Cavitating jet is a jet with cavitation bubbles produced by injecting a high-speed water jet into water (see Fig. 4). The cavitation bubbles take place in the low pressure region of vortex core in the shear layer around the jet. The vortex cavitations combine and big cavitation cloud is produced. When the cavitation cloud hit the surface, cavitation impacts are produced at bubble collapses. Soyama successfully produced cavitating jet in air by injecting a high-speed water jet into a low-speed water jet.
Cavitation S Peening® improves the fatigue strength of gear made of carburized chromium molybdenum steel SCM420H\(^*1\). It also enhances the fatigue strength of carburized chromium molybdenum SCM420\(^*2\) and SCM415\(^*3\), aluminum alloy AC4CH-T6\(^*4\), Duralumin, magnesium alloy, stainless steel, silicon manganese steel and other materials.

---

**Fig. 5** Improvement of fatigue strength of gear demonstrated using a power circulating type gear tester (Carburized SCM420H)\(^*1\)

**Fig. 6** S-N curve of rotating bending fatigue test (Carburized SCM420)\(^*2\)

**Fig. 7** S-N curve of rotating bending fatigue test (Carburized SCM415)\(^*3\)

**Fig. 8** S-N curve of rotating bending fatigue test (AC4CH-T6)\(^*4\)


Cavitation S Peening® introduces compressive residual stress with a considerable less surface roughness compared to that from shot peening (see Figs. 9 and 10). Individual pit induced by Cavitation S Peening® does not have sharp tip up around the pit, compared to a pit induced by ball indentation at nearly constant volume and depth (see Fig. 11). It is very shallow compared to the pit at constant depth of plastic deformation area (see Fig. 12).


Singularity of CSP

Full width at half maximum of diffracted X-ray profile from alloy tool steel peened by Cavitation S Peening® becomes narrower than that of not peened specimen (see Fig. 13). The ratio of arc height between N-gage and A-gage of Almen strip peened by Cavitation S Peening® is different from that of shot peening (see Fig. 14).

Peening Effect

Cavitation S Peening® can be applied for suppression of cracks induced by heat cycle (see Fig. 15), relief of micro strain (see Fig. 16), peen forming (see Fig. 17), and enhancement of CVT element (see Fig. 18).

Fig. 13 Diffracted X-ray profile and peened surface of alloy tool steel SKD61*9

Fig. 14 Relation on arc height between N-and A-gauge, and surface of Almen strip*10

Fig. 15 Number of cracks after heat cycle test*11

Fig. 16 Relief of micro strain by CSP*12

Fig. 17 Curvature induced by CSP*13

Fig. 18 S-N curve of CVT elements*14


