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Surface mechanics design of metallic materials by cavitation peening

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Cavitation normally causes damage in hydraulic machineries such as pumps and screw propellers, as severe impacts are produced at cavitation collapses. However, cavitation impacts can be utilized for surface mechanics design for improvement of fatigue strength in the same way of shot peening. The peening method using cavitation impacts is named as "cavitation peening". The advantage of cavitation peening is that the increase of surface roughness is small comparing with conventional shot peening, as shots are not required in cavitation peening. In order to mitigate stress corrosion cracking, introduction of compressive residual using cavitation impact was proposed, and it has been applied for nuclear power plants. By enhancing cavitation impacts, improvement of fatigue strength was demonstrated.The aspect of cavitation peening of gear by using a submerged water jet with cavitation, i.e., a cavitating jet. In order to investigate mechanism of improvement of fatigue strength, a special fatigue tester was developed to investigate crack propagation in surface modified layer. Cavitation peening also suppress hydrogen embrittlement. At laser peening, it is believed that impact caused by laser abrasion produces plastic deformation for surface treatment. However, a bubble is generated after laser abrasion, and it produces impact at bubble collapse like cavitation, then it can be called as laser cavitation. As shown in Fig. 2, when the impact passing through the material was measured, the impact induced by laser abrasion is larger than that of laser abrasion. Namely, at submerged laser peening, peening effect would be improved by considering the laser cavitation. In the presentation, the principal of cavitation peening is introduced with applications of cavitation peening such as improvement of fatigue strength and suppression of hydrogen embrittlement. The work was partly supported by Osawa Scientific Studies Grants Foundation.

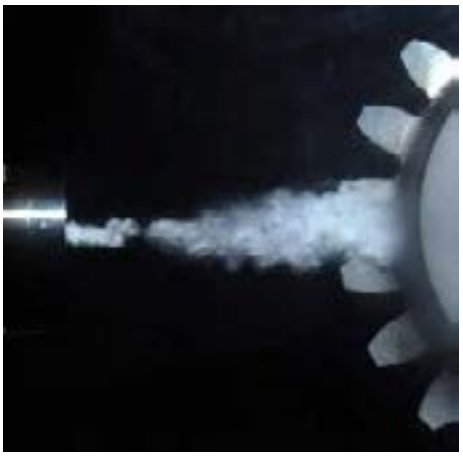

Figure2: *Laser abrasion and laser cavitation at submerged laser peening by a cavitating jet*

Biography

Hitoshi Soyama is Professor of Department of Finemechanics at Tohoku University, Japan, He is a Fellow of American Society of Mechanical Engineers ASME and a honorary member of Water Jet Technology Society of Japan. He is known for his work in the fields of cavitation and its practical applications such as water treatment and mechanical surface treatment, i.e., cavitation peening. Although cavitation impacts causes severe damage in hydraulic machineries, his research utilized cavitation impacts for enhancement of fatigue properties of metallic materials. He established evaluation methods using inverse analysis to investigate mechanical properties of surface modified layer. Now, he has been applied the evaluation methods to mechanical properties of products of additive manufacturing. He proposed additive manufacturing of laser melting using oxide iron on Mars and/or Moon. It was revealed that oxygen was obtained during the process.

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