2024 年 6 月 3～8 日にチェコのプラハで開催された「第 11 回残留応力に関する欧州会議」（the 11th European Conference on Residual Stresses: ECRS-11, 2024）において、以下の研究発表を行いました。本研究の一部は、公益財団法人ＪＫＡによる競輪の補助を受けて実施しました。

Simultaneous improvement of fatigue strength and biocompatibility of Ti-6Al-4V by low-energy laser peening

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Laser peening (LP) has been applied to relatively large mechanical components and structures, such as turbine blades and nuclear reactor welds, for improving fatigue strength and preventing stress corrosion cracking, because LP can introduce deeper residual stresses than other mechanical surface treatment techniques. One other unique feature of LP is the precise controllability of the laser irradiation conditions including laser energy, pulse width, spot diameter, pulse density. Therefore, LP has excellent applicability to localized areas and small components. In particular, the low-energy LPwC utilizing recently developed low-energy and short-pulse laser sources is considered to be highly applicable to small components. In the low-energy LPwC, a low-energy laser source with a laser energy of a few mJ, which is about one-hundredth that of conventional laser peening is used. Even with a low laser energy, the peak power density which is a measure of the pressure of plasma shock wave become sufficiently high by reducing the laser spot diameter and the pulse width, thus enabling the generation of compressive residual stresses in the surface layer of metallic materials.

The authors are working on improving the fatigue properties of small components using the low-energy LPwC. One of the applications is dental and surgical implants. Titanium alloys are mainly used for the load-bearing parts of implants. Both of fatigue strength and biocompatibility are important factors for the implant design, however, it is difficult to reconcile both. To improve the biocompatibility of titanium alloys, an appropriate surface roughness is required, and the surface roughness is introduced into the surface by surface treatment techniques, such as chemical etching, grit blasting, and oxidizing. However, these surface treatments often leads to a reduction in fatigue strength. In the present study, we revealed that the low-energy LPwC can improve both the fatigue strength and biocompatibility of a titanium alloy, simultaneously.

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