

## 論文内容要旨

報告番号	甲 先 第 <b>172</b> 号	氏 名	武 博
学位論文題目	Study on fatigue properties of S45C steel after hybrid surface treatments of ultrasonic nanocrystal surface modification and plasma nitriding 超音波ナノ結晶表面処理及びプラズマ窒化したS45C鋼の疲労特性に関する研究		
<p>内容要旨</p> <p>Surface treatment is an important method to improve fatigue strength and has been used widely in production. The severe surface plastic deformation (<math>S^2PD</math>) as a new surface treatment can improve the strength, microhardness, and bring high compressive residual stress into the materials top surface. With this method, many kinds of <math>S^2PD</math> were invented and carried out on various metal materials. In this study ultrasonic nanocrystal surface modification (UNSM) was employed on the surface treatment of S45C steel to enhance the fatigue properties. And a stronger surface layer produced by plasma nitriding combined with UNSM was also studied.</p> <p>In chapter 1, the <math>S^2PD</math> method of surface treatment will be stated and also its effect to the fatigue properties, the research about the application of <math>S^2PD</math> method into the thermal diffusion treatment would be introduced. The research background and purpose of this study also would be introduced.</p> <p>In chapter 2, the surface process methods and the experimental methods would be introduced. The principle of the UNSM and the plasma nitriding would be described. The characterization methods, such as hardness test, microstructure observation, Nitrogen content measurement, residual stress measurement, surface morphology observation, scanning electron microscopy, X-ray diffraction would be utilized to study the characterization of the surface layer produced in surface treatment. Also the fatigue test and analytical methods would be introduced.</p> <p>In chapter 3, UNSM was carried out on the surface treatment of S45C steel. The results of surface morphology, roughness, residual stress, and the hardening</p>			

zone would be shown and a comparison among different UNSM parameters would be taken to discuss the effect of UNSM to the fatigue strength of S45C steel. For the quenched and tempered S45C steel the best static load is 50 N. The fatigue strength was also enhanced, however sub-surface crack between hardening layer induced by UNSM and the basic metal could be observed.

In chapter 4, UNSM has been employed to improve the surface properties of nitriding specimens. The characterization of the top surface layer (surface morphology, surface roughness, residual stress and harden surface zone) has been studied. The residual stress has an opposite reaction as the increase of strike number. The fatigue strength has a close relation with the value of residual stress and effect of strike number to the sub-surface cracks was found. For the  $\Delta K_{\text{facet}}$ , an estimated value is close to the average value calculated from the test results.

In chapter 5, the UNSM was brought into the plasma nitriding of S45C steel. After the characterization test, the surface morphology, compound layers were studied and found that UNSM had no influence to the compositions of the nitriding layers. The growth of the thickness for the compound layer was found and the results show that compared with the un-UNSMed sample enhancement of surface hardness, effective nitrogen diffusivity, and fatigue strength were obtained. However a decrease of fatigue limit of UNSMed sample with nitriding 48 h was found induced by the surface defects.

In chapter 6, all the properties of UNSM and plasma nitriding surface treatments were summarized. The characteristics of the different surface treatments were investigated and the fatigue properties were studied. Plasma nitriding still was the best choice for enhancing of the fatigue properties of S45C steel. Though the hybrid surface treatments of ultrasonic nanocrystal surface modification and plasma nitriding was carried out on the surface treatment for S45C steel and some advantages can be found, limitations for the long time of nitriding and high processing density of UNSM hindered the application of these hybrid surface treatments.

論文審査の結果の要旨

報告番号	甲工 第 172 号 甲先	氏 名	武 博
審査委員	主査 石 田 徹 副査 村 上 理 一 副査 長 谷 崎 和 洋 副査 米 倉 大 介		
学位論文題目 Study on fatigue properties of S45C steel after hybrid surface treatments of ultrasonic nanocrystal surface modification and plasma nitriding (超音波ナノ結晶表面処理及びプラズマ窒化したS45C鋼の疲労特性に関する研究)			
審査結果の要旨 本研究は、S45C に超音波ナノ結晶化表面処理及びプラズマ窒化処理を組み合わせた表面処理を行った材料の疲労特性の解析を扱ったものである。S45C に超音波ナノ結晶化処理を行うと疲労特性は向上することを明らかにし、また、プラズマ窒化処理を行うと同様な効果が認められることを明らかにした。 本研究では、超音波ナノ結晶化表面処理とプラズマ窒化処理が S45C の疲労特性の向上に有効であることを明らかにしたものである。 まず、超音波ナノ結晶化表面処理法を用い、S45C の表面にナノ結晶を作った。また、プラズマ窒化処理を行い、窒化層を作った。これらの表面処理層が疲労特性の向上に有効であることを実験的に明らかにしている。また、超音波ナノ結晶とプラズマ窒化層を組み合わせることによりさらに疲労特性の向上を図ったところに彼自身の創意と工夫が見られる。 以上本研究は、超音波ナノ結晶化表面処理法とプラズマ窒化処理法を扱った優れた論文であり、本論文は博士（工学）の学位授与に値するものと判定する。			