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**July 15, 2019**

Dear Editor:

Thanks very much for your suggestions and the comments about our manuscript entitled “***Property optimization of low-cycle fatigue in AlSi piston alloy at elevated temperatures by ultrasonic melt treatment (Ref: JMRT\_2019\_341)***” which was submitted for publication in ***Journal of Materials Research and Technology.*** We appreciate very much for the kindness of the referees, who gave us a valuable suggestion to improve this manuscript again. We have tried to revise the manuscript according to the comments, and all the changes are marked in blue in the revised manuscript and the corresponding corrections are listed in detail below.

**Comments from the editors and reviewers:**

**Reviewer #1:**

The paper (JMRT\_2019\_341) presents an experimental investigation on low-cycle fatigue properties of AlSi alloy at room and elevated temperatures. Two processes were compared, namely as-cast and ultrasonic melt treatment conditions. Fatigue performances were interpreted in terms of energy per cycle and two material parameters – the fatigue toughness and fatigue exponent – were analysed to describe quantitatively the improvement obtained with the UT treatment. The paper is well organised and the physics of fatigue damage is investigated thoroughly. Nevertheless, in my opinion some points should be clarified according to the following points:

**Responses to the comments of Reviewer #1:**

**Reviewer 1#- Q1:** Section 3.3: “At low strain amplitude, the SR decreases with increasing temperature; however, the SR shows a reverse trend for high strain amplitude. The critical strain for cyclic softening transition is about 0.2% for AC alloy and 0.4% for UT alloy (Fig. 4c).” This statement is not clear to me, in that figure 4c does not show an increasing followed by a decreasing trend of the SR parameter.

Re: According to the reviewer’s suggestion, the inappropriate description (eg: cyclic softening in **3.3. Cyclic deformation behaviors**) has been deleted or revised.

“Some common characteristics can be seen in the alloy: First, the fatigue life increases with decreasing strain amplitude, while the cyclic stress increases with increasing strain amplitude for all the tested temperatures. Second, the cyclic softening occurs remarkably or slightly depending on the temperature and strain amplitude. Third, the half-life hysteresis loops (Figs. 4c and d) indicate that the cyclic stress decreases and cyclic plastic strain increases obviously at higher temperature.”

**Reviewer 1#- Q2:**  Section 4.1: “The hysteresis energy (Ws) displays cyclic stability after several cycles for all the strain amplitudes (Fig. 5).” Indeed Figure 5 shows that stabilisation is not attained at  all applied strain amplitudes. I recommend to re-formulate this sentence and explain which characteristic value of Ws has been used in fatigue life Eq. (2)

Re: According to the reviewer’s suggestion, the inappropriate description (The hysteresis energy (Ws) displays cyclic stability after several cycles for all the strain amplitudes (Fig. 5) in **Section 4.1**) has been deleted. The explanatory words have been added in the revised manuscript: “The hysteresis energy (*W*s) involving both strain and stress amplitudes shows more stable than stress or strain solely and can be used more reasonably to evaluate the fatigue property. The *N*f-*W*s relationships on log-log scales display the crossover of LCF life curves at elevated temperatures (the *W*s here were acquired from half-life time).”

**Reviewer 1#- Q3:**  Section 4.1: “On the other hand, the Tc decreases for UT alloy, which means that the refined phases and prolonged fatigue life will increase the time-dependent damage.” This sentence is not clear in my opinion, because the concepts of “prolonged life” and “increase of time-dependent damage” do not match.

Re: According to the reviewer’s suggestion, the inappropriate description (in **Section 4.1**) has been revised. “On the other hand, the *T*c decreases for UT alloy, which means that the refined phases and prolonged fatigue life will increase the proportion of time-dependent damage.”

**Reviewer 1#- Q4:** Figure 7: I recommend to report the relative number of cycles at which these picture were taken.

Re: The Fig. 6 (Figure 7 before revise) exhibits the microstructural damage after fracture. And the relative number of cycles is given in the revised manuscript. “**Fig. 6** Microscopic damage characteristics around main fatigue crack at Δ**t2 of 0.2% and different temperatures after fracture: (a) AC-280 °C (N=2246); (b) AC-350 °C (N=13501); (c) AC-425 °C (N=6943); (d) UT-280 °C (N=13915); (e) UT-350 °C (N=17282); (f) UT-425 °C (N=15966).”

**Reviewer 1#- Q5:**  Section 4.2: the concept of “damage range” is not clear in my opinion. It has been defined as “the spacing from the main crack to the fatigue damage zone edge”; however, isn’t the main crack tip itself the fatigue damage zone edge? Therefore, what spacing are the authors talking about?

Re: According to the reviewer’s suggestion, some inappropriate descriptions have been revised in **Section 4.2**. “Both the damage range (the longest distance between secondary cracks and main crack) and the crack density (total length of cracks near fracture surface in unit area) increase with increasing temperature (Fig. 7a).”

**Reviewer 1#- Q6:** Section 4.2 “It is worth noting that the fracture feature is transgranular at all the test temperatures; the grain boundary is not the main damage source even at high temperatures, different from the current view”. Indeed I was surprised to see that grain boundaries are not the preferred site for crack propagation at elevated temperature. Have the authors an explanation for that?

Re: I think the main reason may be that the damage in second phases is more important than grain boundary.

**Reviewer 1#- Q7:** Section 4.3: “the cyclic softening in the AlSi alloys may be attributed to two possible mechanisms: one is macro-phases cracking (such as primary Si and IMs), which is mainly influenced by mechanical strain or stress; the other is evolution of dislocation configurations and micro-phases coarsening”. According to figure 4 a and b, cyclic softening starts at the very beginning of the fatigue test: does macro-phases cracking start at the very beginning of the fatigue life as well? This should be discussed in the paper to support the first mechanism supposed by the authors (see also my remark n° 4)

Re: According to the reviewer’s suggestion, the inappropriate description has been deleted or revised in the **Section 4.3**.

**Reviewer #2:**

In this study, toward improving fatigue life of AlSi piston, experimental fatigue study on samples without and with ultrasonic melt treatment were conducted.  The experimental study validated thru the application of conventional and basic fatigue modeling. The validated result used for establishing optimization strategy.

**Responses to the comments of Reviewer #1:**

**Reviewer 2#- Q1:** The written English of manuscript should be improved.

Re: According to the reviewer’s suggestion, some grammatical mistakes and inappropriate descriptions have been revised (Blue font in marked-up manuscript).

**Reviewer #3:**

The low cycle fatigue behavior of AlSi piston alloys was thoroughly evaluated and analyzed. By reducing size of the microstructural features of casting product utilizing ultrasonic melt treatment, the positive effect working both at low and high temperatures was realized and confirmed. The experimental results and accompanying analytical work are well-executed and meaningful. Therefore, the publication of the manuscript is recommended provided that the following issues are properly addressed.

**Responses to the comments of Reviewer #3:**

**Reviewer 3#- Q1:** The English writing needs significant improvement. The manuscript is full of grammatical errors and awkward expressions. It is highly recommended to consult to a professional proofreader.

Re: According to the reviewer’s suggestion, some grammatical mistakes and inappropriate descriptions have been revised (Blue font in marked-up manuscript).

**Reviewer 3#- Q2:** Also, acronyms like LCF should not be used in abstract.

 Re: According to the reviewer’s suggestion, the explanatory words have been added in the revised manuscript in **Abstract**: “It is found that the fatigue cracks mainly initiated from broken primary Si at low temperature and phase/matrix interface debonding at higher temperature. The transgranular crack propagation can be found for all the temperatures and the grain is obvious reduced after low-cycle fatigue at higher temperature. Furthermore, a hysteresis energy-based life prediction model was developed and utilized. Based on the model, the optimum fatigue life was found at intermediate temperature. A strategy for fatigue property optimization was proposed: increasing *W*0 at low temperature and increasing *β* at high temperature to enhance the fatigue life in entire service temperatures with the ultrasonic melt treatment. In this way, the remarkable improvement of the fatigue properties may be achieved..”

**Reviewer 3#- Q3:** Equation number 1 is incorrectly written as 2.

Re: According to the reviewer’s suggestion, the inaccurate equation number has been revised.

**Reviewer 3#- Q4:** General explanation on the ultrasonic melt treatment and its effect on microstructure should be given in the introduction section.

Re: According to the reviewer’s suggestion, the explanatory words have been added in the revised manuscript**, Introduction. “**Ultrasonic melt treatment is one of the more promising means of improving the mechanical properties of Al alloys, as it effectively reduces the porosity while simultaneously refining the microstructure through cavitation-induced dendrite fragmentation and/or cavitation-induced heterogeneous nucleation”.

**Reviewer 3#- Q5:** TEM sample preparation method could be added.

Re: According to the reviewer’s suggestion, the explanatory words have been added in the revised manuscript, **Section 2. Experimental materials and processes** “Transmission electron microscopy (TEM) samples were cut from the Al-Si alloy samples, ground to a thickness of ~0.05 mm and then twin-jet electro-polished at -20 °C using a solution of 20% perchloric acid and 80% methanol by volume, and the TEM foils were examined using a FEI Tecnai F20 microscope.”

**Reviewer 3#- Q6:** In Figure 3a, dotted lines for graphs of RT and 280 degree C are not visible.

Re: According to the reviewer’s suggestion, the Fig. 3a has been redrawn. The explanatory words have been added in the revised manuscript, **3.2. The tensile and fatigue properties:** “The ultimate tensile strength (UTS) and elongation to fracture of the two alloys can be found in Fig. 3b.”

**Reviewer 3#- Q7:** Overall, the manuscript is very long and difficult to read. To attract more readers, the authors may want to go over the manuscript very carefully and improve their writing so that the contents could be easily understood by the readers.

Re: According to the reviewer’s suggestion, some grammatical mistakes and inappropriate descriptions have been revised.

We thank you very much for your careful considerations and sound advices! It would be very grateful if the revised manuscript could be finally accepted for publication in ***Journal of Materials Research and Technology***. We are looking forward to hearing from you at your earliest convenience.

With best regards!

Yours sincerely,

Dr. Jian-Chao Pang

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Prof. Zhe-Feng Zhang