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An insight into the rough surface effect on fretting characteristics of quenched and tempered steel

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The effect of the rough surface texture and its orientation on the fretting behavior of 34CrNiMo6 steel was investigated via an annular flat-on-flat contact configuration. A lower friction peak in the running-in phase and approximately the same coefficient of friction value in the steady-state one were observed for the rough surfaces than for the smooth ones under gross sliding conditions. However, in the stable friction tests, roughly the same threshold levels were attained for both rough and smooth contacts.

Keywords: Fretting, Rough Surfaces, Friction, Material Characterization

1. Introduction

The surface texture is considered as one of the significant features in fretting failure, which controls contact mechanics. In this regard, an investigation into the impact of rough surfaces on the fretting response of quenched and tempered (QT) steel 34CrNiMo6 was carried out using a large flat-on-flat contact apparatus [1] with a high number of fretting cycles to be more comparable with practical engineering applications. Gaining fundamental knowledge about fretting-induced friction and wear is the main objective.

2. Methods

QT steel as a high strength martensitic steel appropriate for the machine components under dynamic loading conditions was used as self-mated pairs. To fabricate the rough surfaces ($S_a \sim 2$ μm), the curved lines, shown in Fig. 1, were machined on the smooth surfaces ($S_a \sim 0.2$ μm).

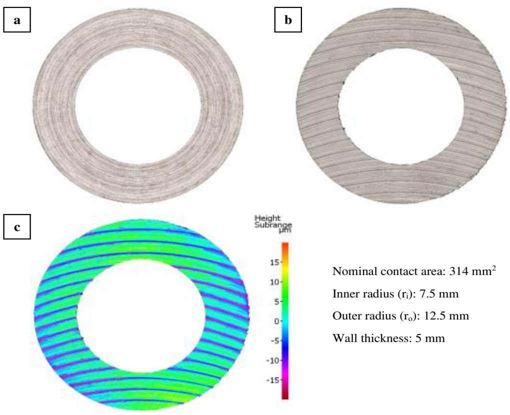

Fig. 1. Optical profilometry images of (a) the smooth and (b) rough specimens, and (c) 3D surface topography of the rough surface.

The nominal normal pressure for all fretting tests was 30 MPa. The three test types, which included long and short duration gross sliding, as well as so-called stable friction were carried out at the ambient temperature and relative humidity [2]. In addition, the effect of contact orientation was considered by accurately positioning the machined lines on one another in parallel and perpendicular orientations. To investigate surface damage, the contacts were imaged by Alicona 3D profilometer. Afterwards, the most severe adhesion spots were selected for further characterization as the most probable areas, including degradation layers and fretting fatigue-induced cracks. A scanning electron microscope (SEM) equipped with an energy dispersive X-ray spectrometer (EDS) was used to study fretting scars and cross-sectional damages.

3. Discussion

The maximum coefficient of friction (COF) for the rough surfaces was lower than for the smooth one, and it was delayed to a later number of fretting cycles. Nevertheless, the steady-state phase elucidated nearly the same COF values for both surface textures and contact orientations. In the rough cases, less areas were subjected to fretting damage, which attested to the effective influence of this kind of texture on fretting performance. Also, the cross-sectional characterization of the adhesion spots will be performed to clarify the severity of the fretting damage. Regarding wear mechanisms, all the damaged contacts revealed a combination of the adhesive and oxidative-abrasive mechanisms under gross sliding tests.

4. References

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