

Gas nitriding process : an effect on steels rolling contact fatigue life and behavior?

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1. Rolling contact fatigue

Mechanisms such as gears, bearings, cams, rails, undergo high repeated loading resulting in harsh contact stresses. Stress cycles in those mechanisms lead to rolling contact fatigue, characterized by crack initiation and propagation in the material, and damages commonly known as micropitting and pitting (Fig.2) [1].

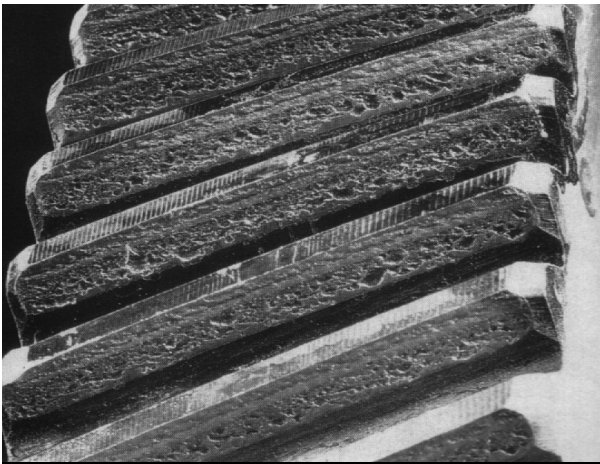


Fig.1 Micropitting and pitting on gear tooth flank.

2. Gas nitriding parameters : influence on the layer

However, thanks to the improvements on the quality of steels and surfaces, it is now possible to increase contact fatigue life.

In particular, gas nitriding is a treatment that hardens the surface layer and introduces subsurface residual compressive stresses, preventing from contact fatigue damage. Indeed, those mechanical properties arise from nitrogen diffusion into the substrate, leading first to nitrogen insertion into the ferritic solid solution, and then to nitride and carbide precipitation [2].

Since the diffusion and precipitation depend on temperature and time, among others, the nitriding process has an impact on the physical and mechanical properties of the treated layers. Besides, the surface treatment parameters control the compressive stress values and depths on the nitrided layer (Fig.2), as described in the literature [3,4].

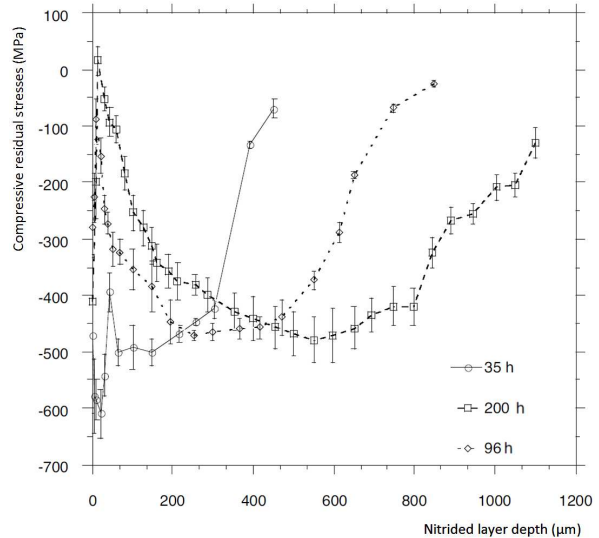


Fig.2 Influence of nitriding temperature (T_n) on residual compressive stresses [4]

3. Rolling contact fatigue on nitrided steel

To fully understand the tribological scenarios, it is interesting to compare the maximum values and depths of the contact-induced stresses and the nitrided layer compressive stresses.

Experiments on twin-disc machine test rigs have led to reveal how the nitriding process may have an impact on rolling contact fatigue life and behavior.

4. References

- [1] A. V. Olver. The mechanism of rolling contact fatigue: An update. *Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology*, 219(5):313–330, 2005.
- [2] S. Jegou, L. Barrallier, and R. Kubler. Phase transformations and induced volume changes in a nitrided ternary Fe–3%Cr–0.345%C alloy. *Acta Materialia*, 58(7):2666 – 2676, 2010.
- [3] L. Barralis, J. Castex and J.C. Chaize. Influence des conditions de traitement sur la distribution des phases et des contraintes résiduelles dans les couches nitrurées. *Mémoires et Etudes Scientifiques Revue de Métallurgie*, 1986.
- [4] Laurent Barrallier. *Genèse des contraintes résiduelles de nitruration. Étude expérimentale et modélisation*. These, Arts et Métiers ParisTech, May 1992.