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FERROMAGNETIC STEEL SURFACE TREATMENT ASSESSMENT FROM MAGNETIC SIGNATURES

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ABSTRACT

The advancement of surface treatments for ferromagnetic steel parts, encompassing both desired processes like nitriding and carburization [1] and undesired conditions like corrosion [2], presents a critical challenge in ensuring the integrity and performance of engineered components. Ferromagnetic behavior is highly complex and sensitive; it encompasses multiple mechanisms and processes that happen over different geometrical scales, and even small effects like very early-stage corrosion can strongly impact it.

This work explores the application of magnetic signature analysis as a nondestructive method for evaluating a spectrum of surface treatments, including the not-so-typical silicon diffusion [3] and the dealloying treatments [4].

Recognizing that the sensitivity of magnetization mechanisms varies with the nature and depth of the treatment, the focus is on identifying and characterizing the most sensitive magnetization mechanism. This approach enhances reproducibility and diminishes dependence on experimental conditions, thereby enabling precise and reliable surface treatment [5].

Magnetic methods prove advantageous for nondestructive evaluation, offering a means to scrutinize surface treatments without compromising the structural integrity of the tested ferromagnetic steel parts.

To implement this approach, it is imperative to define experimental situations wherein the targeted magnetization mechanisms are isolated and stimulated. Techniques, including the magnetic hysteresis loop analysis, the magnetic Barkhausen noise measurement, the magnetic incremental permeability measurements, etc., can stimulate the material in different ways and provide magnetic indicators strongly bonded to a given mechanism.

Importantly, each magnetization mechanism possesses unique characteristics, such as time constants and the amount of required magnetic field, some being frequency-dependent (e.g., microscopic and macroscopic eddy currents) and others not (e.g., reversible and irreversible domain wall motions or magnetization rotation). Leveraging these properties allows for defining experimental situations tailored to isolate specific mechanisms.

This nuanced approach contributes to a more precise and targeted evaluation of the surface treatments, fostering a deeper understanding of the intricate magnetic responses induced by them.

In conclusion, this abstract highlights the innovative use of magnetic signature analysis to assess surface treatments on ferromagnetic steel parts comprehensively. By identifying the most sensitive magnetization mechanism and tailoring experimental situations to isolate these mechanisms, the study establishes a reliable and controlled framework for characterizing diverse surface treatments. This approach enhances the reproducibility of assessments and

deepens our understanding of the magnetic responses associated with conventional and unconventional surface treatments in ferromagnetic steel components.

In the upcoming presentation, I will investigate specific experimental scenarios that isolate and stimulate magnetization mechanisms sensitive to different surface treatments. I will go through a large range of surface treatments and establish the best magnetization mechanism and the best scenario to assess them. Then, based on these specific examples, I'll try to explain and understand the origin and the reason for these good correlations.

References

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