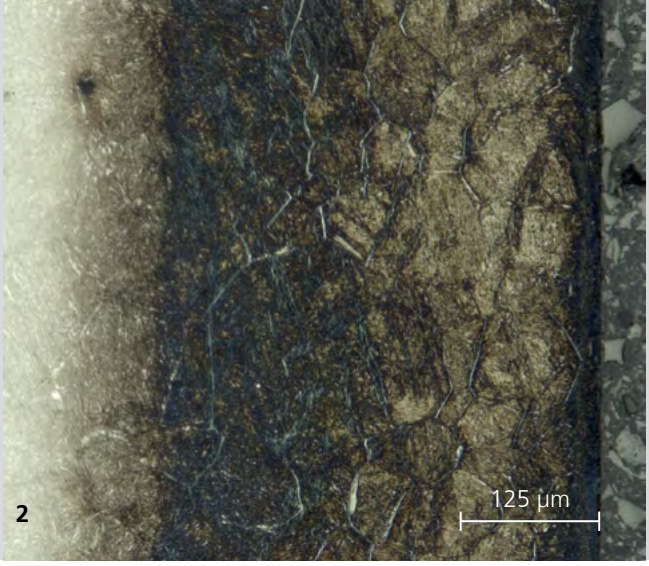
1



2

PREDICTION OF PLASMA NITRIDING RESULTS

Plasma nitriding is an established process for the surface-hardening of steels and is implemented for a multitude of tools and components. The nitriding result, thereby, depends considerably on the utilized steel materials and the process parameters. Knowledge concerning the process control is largely based on empirical values with frequently used materials. In order to select an ideal plasma nitriding process for new materials and applications, elaborate preliminary tests are generally necessary. At Fraunhofer IST, a prediction tool has therefore been developed forecasting the results of plasma nitriding processes, thereby, enabling an improvement in the quality of treated components.

New possibilities for end users

Users of plasma nitriding technology are often faced with the decision as to which specifications should be made for an optimum nitriding result and which process parameters must be set for this purpose. Generally, the specifications are limited to an indication of the desired nitriding hardness depth, and standard processes for the nitriding are implemented which are not optimally coordinated with the material, the geometry or the end application. The potential of plasma nitriding technology is therefore often not fully exploited. In this respect, the new software-based prediction tool from Fraunhofer IST offers users extensive possibilities regarding improving the quality of the components.

Factors influencing the nitriding result

Complex relationships exist between the nitriding parameters, such as treatment duration, process temperature and gas composition, the alloying elements contained in the base material the component geometry and the nitriding result. The most important characteristic values are:

- The nitriding hardness depth and the hardness gradient in the material, which can be taken from the determined hardness depth profiles (see Figure 2 and adjacent diagram).
- The compound layer formed on the surface of the material, which can vary both in its chemical composition (Fe_4N, $Fe_{2-3}N$) and thickness. An almost complete suppression is also possible
- The crack sensitivity of the nitrided surface under load can, for example, be determined analogously to the Rockwell penetration test in accordance with DIN 4856:2018-02. For this purpose, a separate evaluation scheme for nitrided surfaces has already been developed in earlier work.

Data collection through sample evaluation

In the past, secure knowledge was lacking regarding the relationships between the nitriding parameters, the base materials and the nitriding result as well as the necessary database. Within the framework of the IGF project "Prognosetool für Plasmanitrierprozesse zur Randschichtbehandlung von Werkzeugen und Bauteilen" (Prediction tool for plasma nitriding processes for the surface treatment of tools and components, ProgPlas), more than 500 combinations of widely differing materials and process parameters were investigated. Subsequently, the treated samples were comprehensively evaluated. For validation of the results, comparative tests were performed on industrial facilities. Simultaneously, in cooperation with the Institute of Materials Science and Engineering (IWW) at the Chemnitz University of Technology, a neural network was trained using the data, which provides the basis for the development of a software-based prediction tool for plasma nitriding processes.

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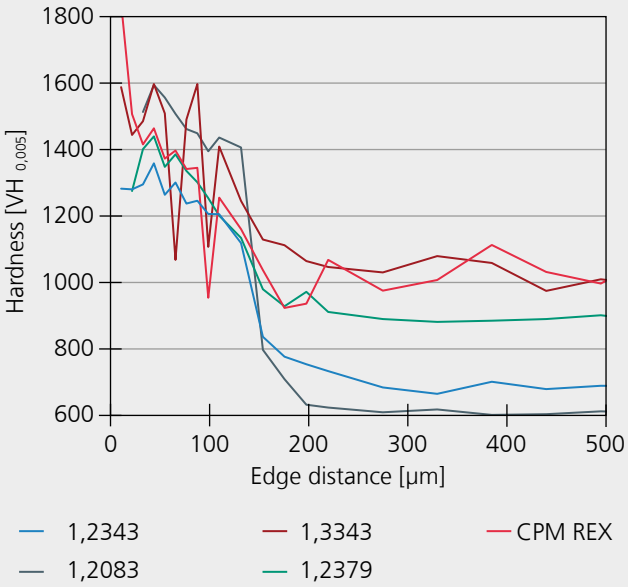
1 *Components during plasma nitriding treatment.*

2 *Microstructure of a nitrided surface zone.*



The resulting hardness depth profile dependent on the material.

Benefits for the user

The results of the investigations were compiled in the form of a user-friendly data collection, which makes it possible to estimate the nitriding result, e. g. for given material and process parameters or, alternatively, to specifically select the required process parameters for the desired nitriding result. Due to the comprehensive database, the potential of plasma nitriding technology can be utilized in the best possible way. Through the optimized approaches, both the tool life and the service life of components can be extended considerably.

The project

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