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# Behaviour of steels in plasma nitriding at low pressure using a plasma beam source

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Different steels have been thermochemically nitrided by using a plasma beam source. A very low total pressure in the range of 0.07 - 5 Pa was applied during plasma nitriding. The heat-treatment duration, nitriding temperature, total pressure, gas composition, energy of the species and the bias voltage have been varied. Four different steels have been selected for the plasma nitriding: a) low carbon steel, b) medium carbon steel, c) high carbon steel and d) austenitic stainless steel. Characterisation has been conducted by light optical microscopy of metallographic polished samples, scanning electron microscopy, X-ray diffraction, glow discharge optical emission spectroscopy, hardness measurements, corrosion testing and pin-on-disk wear tests.
For the low carbon steel a nitriding depth up to 365 µm (8 h, 550 °C) has been observed. This is comparable with data reported by Spies et al. for different nitriding processes [1]. The thermochemical heat treatment with the plasma beam source resulted in plasma nitrided samples with and without compound layer. When a compound layer occurred on the low carbon steel, it mainly consisted of γ-$Fe_4N$. The sample with the highest amount of γ-$Fe_4N$ showed the best corrosion behaviour in salt spray testing. For the same parameter set, the nitriding depth was similar for low and medium carbon steels. However, a much lower nitriding depth was measured for high carbon steel. The nitriding temperature of stainless steel was kept below 450 °C to avoid the degradation of the corrosion behaviour, due to formation of chromium nitride. The corrosion tests revealed that this goal has been achieved by temperature control of the samples on the heating stage in the range of 300-450°C. Only a shallow nitriding of the stainless steel was possible due to the high alloy content of the steel. In XRD patterns the occurrence of the nitrogen expanded austenite phase has been observed. [1] H.-J. Spies et al., Z. Werkst. Wärmebeh. Fertigung 60 (2005) 4.

**Keywords**
Plasma nitriding
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Microstructure
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