Heating Effect on Nitrogen Content and Forming Behaviour of High Nitrogen Steel in Bulk Forming

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Abstract. As a result of the trend towards lightweight design in various industrial sectors like the automotive industry during the last years, mechanical joining methods become increasingly important. These methods make multi-material design possible, while thermic joining techniques reach their limits. Semitubular self-piercing riveting is a mechanical joining technology which allows joining dissimilar materials by using rivets as fasteners. The manufacturing of the rivets, however, is costly and time-consuming, as the rivets conventionally have to be hardened, tempered and coated after forming, in order to achieve adequate strength and corrosion resistance. By using high nitrogen steel for the rivets, these additional process steps are not necessary anymore; hence, the rivet production becomes more efficient. Because of the strengthening, caused by strain hardening, high-strength parts can be produced by cold bulk forming of high-strength steels. However, pressure-nitrided steels are still rarely used in cold bulk forming due to the high tool loads, which is a major challenge for the manufacturing process. Under those circumstances, there is a need for new approaches to manufacturing with the aim of reducing the tool loads and realising the production of rivets made of pressure-nitrided steel. One possibility is the forming at elevated temperatures below recrystallisation temperature. For this purpose, possible changes in nitrogen content caused by the heating of the material have to be investigated. In this way, the limits of the temperature range for forming operations can be defined and negative effects on the material properties due to changes in nitrogen content can be evaluated. After the heat treatment of high nitrogen steel at different temperatures, the nitrogen content is determined using energy dispersive X-ray spectroscopy. Moreover, compression tests are conducted, in order to investigate the influence of the heating of the material on its forming behaviour.