PO2024

Surface hardening after hard coating deposition – combining TiAlN tribological coatings with subsequent electron beam treatment

Kai Weigel[1], Martin Keunecke[1], Klaus Bewilogua[1], Günter Bräuer[1], Gundis Grumbt[2], Rolf Zenker[2], Horst Biermann[2]

[1]Fraunhofer IST, Braunschweig, Germany [2]TU Bergakademie Freiberg, Freiberg, Germany

kai.weigel@ist.fraunhofer.de

Hard coatings cannot exploit the full range of their excellent properties on soft and ductile steel substrates. Therefore, an additional heat treatment before or after the coating process is necessary. Especially if the coating deposition requires higher temperatures a surface hardening after coating deposition is an effective new approach.
In these investigations a subsequent electron beam hardening was applied for the heat-treatable steel 51CrV4 with $Ti_{(1-x)}Al_xN$ top coatings where x ranged from 0.3 to 0.6. The coatings with variable compositions and mechanical properties were deposited by reactive magnetron sputter deposition. For electron beam surface hardening after hard coating the energy distribution within the energy transfer field caused a nearly constant hardening temperature on the treated material surface. Besides composition and structure of the coatings before and after electron beam treatment their hardness and adhesion were studied. Morphology and mechanical properties of the coatings remained nearly unchanged, whereas the coating-substrate interface was highly modified. Diffusion of interface-near coating elements into the substrate occured and the corresponding region of the substrate showed clear changes in morphology and composition. These changes can be correlated with substantial improvements of the coating adhesion properties.
Based on temperature measurements and calculations of electron penetration depths a plausible description of the observed effects was derived. The electron beam hardening caused a significant improvement in delamination resistance, especially for coatings with insufficient adhesion properties. The considered combination of coating deposition and subsequent electron beam hardening seems to have a substantial potential for locally highly loaded components.

Keywords
hard coating
combined treatment
electron beam
TiAlN
case hardening