POC001

Low pressure BCl3 gas boriding of hot working materials

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Because of high temperatures in the contact zone of up to 1,000 °C, tools for the hot extrusion molding of copper and brass require surfaces with high thermal stability. In addition, the high pressure used for plastic deformation in this hot forming process increases the demand for hard and wear resistant surfaces, while the hot and very reactive copper or brass tend to stick at the surface and cause adhesive wear. Often-used hot forming tool materials, like hot working steel AISI H11 and DIN ISO 1.2367, Alloy 718 DIN ISO 2.4668, and Stellite Alloy 1, are known for low service lifetimes in this application. However, these materials, thermochemically treated by boriding, are developing hard and thermally stable layers, and possibly increase the wear resistance in this harsh environment. The boriding process is carried out at low pressure of p = 3 - 7 mbar and temperatures ranging from T = 720°C to 900°C. Under these conditions, the thermal energy is sufficient to decompose BCl_3 and form MeB_x metalborides at the surface in the case of hot working steels or Alloy 718 with layer thicknesses of 8 - 10 and 10 - 15 µm, respectively. Stellite Alloy 1 needs additional energy from DC-pulsed plasma to form a comparable, but thinner (ca. 2 µm) MeB_x layer at T = 730°C. The boride layers show high hardness (2,000 - 2,500 $HV_{0.05}$), an increase in thermal stability and oxidation resistance, and strong adhesion to the substrate. The strong adhesion of the formed thin layer may be due to thermochemical diffusion processes. This is different to ceramic coatings, which create a sharp interface between the dissimilar metal substrate und ceramic coating. The thermochemical treatment during boriding converts the metallic phases of the edge layer into MeB_x phases with a strong adherence to the substrate.

Keywords
boriding
hot forming
wear resistant