Surface Engineering - Applied Research and Industrial Applications
Room Pacific F-G - Session G2-1-WeM

Surface Modification of Components in Automotive, Aerospace and Manufacturing Applications I
Moderator: Jan-Ole Achenbach, KCS Europe GmbH, Germany

11:00am **G2-1-WeM-10 Enhanced Tool Surface Properties Against Adhesion in Aluminum Forging***, **Hanno Paschke**, T. Brueckner,* Fraunhofer IST am DOC, Germany*; A. Thewes,* Institute for Surface Technology, TU Braunschweig, Germany*; J. Peddinghaus,* Institute of Forming Technology and Machines, Leibniz University Hanover, Germany

The occurring wear during aluminum processing in warm bulk forming limits the economic potential of this highly productive process. Mainly due to the occurring adhesive mechanisms during contact between aluminum and hot working steel, a reconditioning of the forging dies is necessary. A tribological optimization of the system is necessary. Compared to steel forging the investigations in aluminum forging are still limited to a simplified level so far. The presented work aims at filling this gap introducing a holistic analytic approach. Different prospective surface modifications are tribologically characterized in a tribometer with ball-on-disc test. Processing level is approximated with ring compression tests and serial forging tests as well. This investigation route allows the identification of influencing factors during material processing such as lubrication effects and the role of anti-adhesive surface chemistry. Thus, it is possible to evaluate the suitability of different tool coatings based on CrXN (X representing dopant), Ti-B-X multiphase systems (X representing additional elements like Si, C and N) and DLC coatings. Diffusion treatments including a boriding treatment were investigated as well.

The general findings reveal adhesive effects caused by the material flow during processing. When the material flow is deflected at obstacles or by high friction, the passive layer breaks and uncovers pure aluminum. Thus, an enlargement of the active surface of the aluminum occurs. An additional superposition of the contact pressure increases this effect. The presented work tries to focus on the industrial application in order to reveal the potential of coated tools to achieve a significant reduction of aluminum adhesion. Thus, an economic processing is possible by extended service life time and reduced downtime.

11:20am **G2-1-WeM-11 Evaluation of Permanent Thin-Film Coatings Applied to Die Surfaces to Reduce Lubricant Use during Aluminum Forging Operations***, J. Vazquez Gonzalez, **Stephen Midson**, A. Korenyi-Both, K. Clarke,* Colorado School of Mines, USA

During the forging process, conventional lubricants such as oils and graphite are applied to the faces of the forging tool, to reduce friction and to minimize transfer of the forged material to the die faces. Although currently required for successful forging operations, there are a number of disadvantages associated with the use of such lubricants, including reduction in part quality, decreased die life, higher costs, increased cycle time, and environmental issues associated with the cleanliness of the workspace. The objective of the research described in this presentation is to reduce or eliminate the need for conventional lubricants during forging through the use of permanent thin-film lubricious coatings applied to the faces of the forging die. Rather than using conventional pin-on-disk type testing to measure friction, this study utilized a functional ring forging test (RFT), where the deformation characteristics of a ring-shaped sample provide an estimate of the level of friction developed during forging. The samples used for forging were rings of aluminum alloy 6061, 25 mm OD, 12.5 mm ID, and 8.4 mm tall. Forging was performed using an instrumented 100 kip forging press. Various thin-film coatings have been evaluated, and testing has been performed at both room and elevated temperatures, and in the lubricated and un-lubricated conditions. The results have shown that two classes of coatings can significantly reduce friction during un-lubricated laboratory ring forging operations, diamond-like carbon (DLC) and a commercial coating containing both graphitic and molybdenum disulfide particles. The results of the testing will be reported, along with analytical testing of the structure and compositions of the coatings.

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