P1: Improvement of Machining Performance in Electrical Discharge Machining using Dielectric-encased Wire Electrode for Deep, Narrow Hole Fabrication in Metal

N. SATO, S. KUMAGAI, K. TAKEDA, Akita Prefectural University,
E-mail: kumagai@akita-pu.ac.jp

We are developing a new electrical discharge machining (EDM) system in order to fabricate a narrow, deep hole in metal. Instead of a conventional pipe electrode system, a wire encased in a dielectric pipe which served as a jacket was employed as the tool electrode in this system. A role of the jacket is to completely suppress unnecessary secondary discharges occurring between the sidewalls of the wire and the fabricated hole. The working fluid flows between the external wall of the wire and the interior wall of the jacket to cool down the drilled portion and to flush out residual debris produced as a byproduct of drilling. In the present study, we examined an effectiveness of a combinational use of conductive working fluid and a capacitor connected to the work piece and the tool electrode. The machining speed under this combinational use (saline water at 150-250 μS/cm and capacitance at about 8 μF) was twice or more higher than that under no use of a capacitor and saline water in fabricating a hole (diameter: 0.8-0.9 mm) in a 20 mm thick carbon steel block.

P2: Optimization of Thermal Preprocessing for Efficient Combustion of Woody Biomass

S. KUMAGAI, M. ARANAI, K. TAKEDA, Akita Prefectural University;
Y. ENDA, Industrial Technology Center of Akita Prefecture,
E-mail: kumagai@akita-pu.ac.jp

A thermal power plant using scrap woods is a small-scale, on-site and carbon-neutral system, providing several benefits over existing large-scale power plants. Its latent moisture and hygroscopic nature, which causes moisture uptake, reduce and fluctuate the generated power converted by the heating value of wood combustion due to endothermic vaporization of moisture. Higher temperatures can remove more moisture adsorbed in woods in a shorter time, but may also remove more flammable matters contributing to heat release during combustion. In the present study, we studied moisture release in the stem and bark of Japanese cedar grown in Akita Prefecture, Japan, during air drying in an oven. Higher and lower heating values of the stems and bark dried at different temperatures and for different lengths of time were evaluated. The optimum drying condition accomplishing the largest net heating value was obtained with stems dried at 180 °C for 30 min.

P3: Evaluation of Erosive Wear Properties of High V-Cr-Ni Cast Iron with Spheroidal Carbides

K. SHIMIZU, XINBAYAER, T. MOMONO, Muroran Institute of Technology;
H. MATSUMOTO, Y. MAEDA, K. SUGAWARA, Sankyo Co., Ltd.,
E-mail: shimizu@mmm.muroran-it.ac.jp

To clarify the erosion mechanism of high V-Cr-Ni cast iron with spheroidal carbides, the authors carried out erosion tests using a shot blast machine with silica sand of average diameter 450μm and observed vertical section near the surface. Furthermore, it was recognized that the hardness of eroded surface after erosion test (482HV) is higher than that (399HV) of specimen before test. High V-Cr-Ni cast iron with spheroidal carbides showed better characteristics of resistance of sand erosion because of its work-hardening effect. It can be made a conclusion that the mechanisms of High V-Cr-Ni cast iron with spheroidal carbides also is, just like the others materials that have been concluded previous study, the cutting wear and deformation wear.

P4: Precision Small Angle Bending of Sheet Metals Using Shear Deformation

K. HIROTA, Kyushu Institute of Technology; Y. M O R I, Tokai Pressing Co., Ltd.,
E-mail: hirota@post.matsc.kyutech.ac.jp

In sheet metal bending, bending tools are designed in prospect of spring back after unloading. Although the accuracy of spring back analysis has been improved, small errors in thickness or material properties lead to variations in bend angles, which become marked especially in bending high strength metals or high modulus metals. In order to correct the bend angle, we proposed a new method for small angle bending. In this process, a sheet metal is slightly bent by shear deformation under the negative clearance conditions. Experiments with pure aluminum, high strength steels and phosphor bronzes revealed that bend angles were determined by the localized material flow around the punch edge and that it could be changed by tool conditions. In addition, a good linear relationship between the penetration depth of punch and the bend angle was observed, which was effective to control bend angles in this process. Based on this relationship, optimum bending conditions were shown and flexible and precision bending within 10-degree angle was demonstrated with one punch-die system by changing tool conditions. This method was applied to correct the angular deviation in U-bend products of high-strength steel and to bend leaf springs of phosphor bronze at an arbitrary small angle.

P5: Dry Cutting of Corona-Discharge Plasma Radiated Stainless Steel

Z. CHUNYAN, K. TAGASHIRA, Muroran Institute of Technology;
S. IKEDA, Tomakomai National College of Technology,
E-mail: s1461014@mmm.muroran-it.ac.jp

Effects of corona-discharge plasma radiation on the surface of austenitic stainless steel (JIS SUS304) have been studied on orthogonal dry cutting. The size of cutting surface was 1.5mm in width and 75mm in length, the cutting speed was 1.67mm/s, and the radiating time was focused on 1s. When the depth of final pre-cut: tf=1=10μm and the depth of finish cut: tf =20μm, the cutting forces and their periodic fluctuation increased at the radiated region as compared to the non-radiated region for the pre-cut specimens. Similar results were obtained from the specimens cut in Ar atmosphere without radiating. The surface finish in the radiated region became poor and the shape of chip changed from the continued tear type for the non-radiated region to the intermittent tear type for the radiated region. In addition, the effects of plasma radiation became weaker with increasing depth of final pre-cut. As the leaving time after plasma radiation got longer, effects of plasma radiation became weaker and almost disappeared after about 16 hours. It would be considered that the fine oxide film on the surface formed after pre-cut was broken and even removed by sputter etching effect of plasma radiation. But with time going on, the oxide film of the surface of the radiated region turns back, and the effects of plasma radiation disappear.

P6: Precise Micro Pattern Replication by Hot Embossing

K. IDEI, Nakanishi Metal Works Co., Ltd.; H. MEKKARU, University of Hyogo;
H. TAKEDA, IKEX Industry Co., Ltd.; T. HATTORI, University of Hyogo,
P7: Analytical Prediction of Fatigue Life on Aluminum Alloy Die Castings for High Performance Parts


In aluminum alloy die castings under cyclic load, a fatigue crack initiates at casting defect and propagates based on $\Delta K_{da}/dN$ relation. The prediction method of fatigue life of aluminum alloy die castings under complex cyclic load has been proposed theoretically and verified experimentally. The paper shows that the prediction method is effective to several shapes of aluminum alloy die castings and it can be applied to the automobile parts under cyclic high load by using the miniature model of actual automobile parts.

P8: Statistical Analysis of Optimum Friction Welding Condition of 5056 Aluminum Alloy Friction Welded Joint

R. TSUJINO, Osaka Institute of Technology; G. KAWAI, Osaka Sangyo University; H. OCHI, Osaka Institute of Technology; H. YAMAGUCHI, K. OGAWA, Osaka Prefecture University; Y. YAMAMOTO, Setsunan University.

The optimum friction welding condition of 5056 Aluminum alloy was investigated. Tested conditions were selected from them showing different unit deformation heat input in the upset stage that can be the index of the soundness of the joint. Statistical analysis of many joints was conducted for judging the appropriateness of the friction welding condition. The results are as follows. (1) The optimum friction welding condition is the one with larger upset pressure after keeping a certain friction heat. (2) The shape parameter of Weibull distribution is the index for judging the appropriateness of the friction welding condition. (3) Clear relationship between the shape parameter and unit deformation heat input in the upset stage can be found. The value of the shape parameter of Weibull distribution for obtaining sound joint steadily is about 80.

P9: Investigation of High Strength Electroformed Ni for Microprobes

T. KIMURA, N. ARITA, H. FUKINBARA, Japan Electronic Materials CORP; T. HATTORI, University of Hyogo.

According to higher function and higher density of rules of LSI, a number of pads becomes larger, and pad pitch of dies becomes finer. We have developed microprobe and have achieved low contact resistance under low contact force only for gold pads. However, an oxide layer formed on aluminum pad surface obstructs stable contacting, higher contact force with strong probe is required. The mechanical properties are tried to improve strength. It is said that downsizing of grain, functionally alloying and impurity addition can improve the material strength. In the electroforming, the additives to the bath are tried here because of its controllability of the process. It is said that the additives have characteristics to control the depositional phenomenon such as crystalline orientation. Alloysulfonic acid sodium salt as the additive is tried. Next, the electroformed nickel is investigated about its mechanical properties. Main estimation factors are Vickers hardness and Young’s modulus because of the material strength can be easily estimated by their values. Improved nickel has a much higher Vickers hardness than Hv600, than the one of Hv450 of the former nickel. And more, it is clarified that Young’s modulus of $E=200GPa$ is much larger than the one of $E=150GPa$ of the former nickel. Thus, high strength of the electroformed probe can be successfully obtained. It was confirmed by the calculation that the contact force is raised about 1.33times as high as the former probe. So, stable contact with low electrical resistance should be achieved in touching on aluminum-copper pad.

P10: Development of Desk Size Superplastic Forming Machine and Several Trials

M. KIMURA, Tokyo National College of Technology, E-mail: kimura@tokyo-ct.ac.jp

The superplastic forging machine of desktop size was developed, and superplastic processing of a superplastic aluminum alloy of 5083 and superplastic zinc alloy, embossing forming, coining forming and thermo plastic injection to superplastic formed products were performed. Rather than the simulation by the finite element method, the physical simulation by solder material is easy, is a short time, and has been realized at low cost. Metal die can be heated in 20 minutes to 520 degrees C of Al alloy superplastic temperature, and at least 850 degrees C of titanium alloy superplastic temperature can be heated in 1 hour by means of cartridge heaters were inserted metal die. The embossing product by using the same material for the superplastic aluminum alloy 5083 with a thickness of 0.5mm which has 3 times as much as height plate thickness with sharp corner was able to be obtained by carrying out 3min-20min holding of the 100kN load at 460 degrees C - 500 degrees C by using the same material as a backup material. The electronic-parts case and auto parts of lightweight and complicated form were able to be obtained by embossing forming of a super-elasticity aluminum alloy. Although embossing forming at the room temperature of pure aluminum was performed for comparison, the corner of a plate thickness distribution or a cast was excellent in the direction of the super-elasticity aluminum alloy 5083. The electronic-parts case and auto parts of lightweight and complicated form were able to be obtained by embossing forming of a superplastic aluminum alloy. Although embossing forming at the room temperature of pure aluminum was performed for comparison, the corner of sharpness and thickness distribution or a forming was excellent in the direction of the superplastic aluminum alloy 5083.

P11: Superplastic Properties Evaluated at Each Small Gauge Part in a Tensile Specimen

A. KURUMADA, Y. MOTOHASHI, G. ITOH, Ibaraki University, E-mail: kurumada@mech.ibaraki.ac.jp

Superplasticity is an interesting high temperature phenomenon that can occur in almost all of crystalline materials. Many studies relating to the microstructures and the occurrence of superplasticity in the materials have been performed. In particular, a number of studies concerning the low temperature or the high strain-rate superplasticity have been carried out from the viewpoint of practical applications. The local deformation such as a necking is easy to occur under the condition of the low temperature and the high strain-rate. Therefore it is important to analyse the superplastic behavior including the necking under these conditions.