SMS-14: Quantitative Evaluation of Delamination in CFRP Laminates by Ultrasonic Wave Sensing Using Optical Fiber Sensors
Y. OKABE, J. KUWAHARA, N. TAKEDA, The University of Tokyo; S. KOJIMA, Hitachi Cable Ltd.,
E-mail: okabe@smart.k.u-tokyo.ac.jp

The authors are constructing a damage detection system using ultrasonic waves. In this system, a piezo-ceramic actuator generates Lamb waves in a carbon fiber reinforced plastic (CFRP) laminate. After the waves propagate in the laminate, transmitted waves are received by a fiber Bragg grating (FBG) sensor, which is kind of optical fiber sensors, using a newly developed high-speed optical wavelength interrogation system. In this research, 1mm FBG sensors were applied to the detection of Lamb waves propagated in CFRP cross-ply laminates. The piezo-actuator put on the laminate excited three-cycle sine waves of 300 kHz repeatedly. The waveforms obtained by the FBG showed that S0 and A0 modes could be detected appropriately. Then, artificial delamination was made in the 0/90 interface of the laminate. When the Lamb waves passed through the delamination, the amplitude decreased and a new wave mode appeared. These phenomena could be well simulated using a finite element method. From the changes in the amplitude ratio and the arrival time of the new mode depending on the delamination length, it was found that this system has a potential to evaluate the interlaminar delamination length quantitatively. Furthermore, small-diameter FBG sensors, whose cladding diameter is about 1/3 of common optical fibers, were embedded in a double-lap type coupon specimen, and the debonding progress could be evaluated using the wavelet transform.

PLF-01: PLASTIC FORMING AND ADVANCED PRODUCTS

PLF-01: Solubility and Dissolution Rate of Ni Base Alloy to Molten Ag-Cu-Pd Brazing Filler Metal
T. IKESHOJI, Y. WATANABE, A. SUZUMURA, T. YAMAZAKI, Tokyo Institute of Technology,
E-mail: watanaby@me.pe.titech.ac.jp

The solubility and the dissolution rate of Ni to the molten Ag-Cu-Pd brazing filler metal is measured. It is noted that the solid surface is eroded unexpectedly large under the flow of the liquid phase even in the combination of the materials, which was conventionally considered not to cause the severe erosion in the staticstate. During the brazing process of the nozzle skirt of LE-7A, the erosion pits are sometimes engraved on the AZ286 pipe surface. In order to estimate the amount of erosion and to prevent it, the solubility and the dissolution rate to the brazing filler metal is measured. In the Ni crucible, Ag-Cu-Pd brazing filler metal was inserted. The crucible heated 1320 K to melt the brazing filler metal and quenched varied the keeping time. The crucible’s cross sections images were observed under the SEM with the EDS. The amount of the dissolved Ni was estimated from the distribution. The solubility was about 6(mass%) and the dissolution rate was 6.25 x 10^(-5)(mass%/s). Using these data, more elaborate dynamic flow can be simulated.

PLF-02: The Search of the Optimum Parameter for Ultrasonic Welding of Aluminum Alloy
H. IMAI, S. MATSUOKA, Toyama Prefectural University,
E-mail: s471001@st.pu-toyama.ac.jp

This paper describes an experimental study on ultrasonic welding of aluminum alloy. There are several of welding technique, in which is expected to replace other welding and brazing processes. The relation between energy density and welding pressure in joining certain types of aluminum alloy was clarified. For example, ultrasonic welding of aluminum alloy can be accomplished under the condition E = K1 \rho_p^1 < f (P, E) \leq K2 \rho_p^2 (E: energy density P: welding pressure). The welding energy increases with the increase in welding pressure, but decreases with the decrease in the material size and pressurization area. The welding energy is effectively used in the ultrasonic welding of flexible, narrow material with a narrow pressurization area. Weldability can be evaluated by observing the amount of subduction of the welding material. Furthermore, oxide film and organic coating are periodically removed from bonded interfaces by ultrasonic wave vibration.

PLF-03: Ultrasonic Welding of Thin Alumina and Aluminum Using Inserts
T. ISHIKURO, S. MATSUOKA, Toyama Prefectural University,
E-mail: ishikuro@toctyama.ac.jp

This paper describes an experimental study of ultrasonic welding of thin ceramics and metals using inserts. Ultrasonic welding has made it possible to join various thick ceramics, such as Al2O3 and ZrO2, to aluminum at room temperature, quickly and easily compared to other welding methods. However, for thin ceramics, which are brittle, welding is difficult to perform without causing damage. In this experiment, anodizing aluminum oxide from which different anodizing time, was used as thin alumina ceramics. Vapor deposition of aluminum alloys was used as an effective binder layer for welding at low pressure and a short duration without causing damage to the anodic oxide film with short anodizing time. For example, the ultrasonic welding of thin Al2O3/Al was accomplished under the conditions of ultrasonic horn top amplitude of 30μm, welding pressure of 5MPa and required duration of 0.1s. However, since vapor deposition film tends to exfoliate as observed in the sample with long anodizing time, welding was difficult.

PLF-04: Experimental Study of Process Design System for Forward Extrusion of Spur Gear
J.H. SONG, Korea Automotive Technology Institute; Y.T. IM, Korea Advanced Institute Science and Technology,
E-mail: jhsong@ktactech.re.kr

In the previous study, a major design parameter predicting filling status of a gear tooth and modified empirical load formula were determined for cold forward extrusion of solid or hollow spur gears. Also, automated process design system with a rule-base was developed. In this study, competitiveness of the developed system was estimated through the experiments. Extrusion die set was designed by the developed system and elastic analysis of dies considering a shrink fit. With variation of the material type and lubricants, hollow and solid gears were extruded. From the experiments, it was found out that filling status of a hollow gear was improved in comparison with that of a solid gear irrespective of the forming conditions and the predicted forming load matched well with the experimental load requirement. From the current study, it was expected that developed system can be efficiently used in the process and die design of gear extrusion.

PLF-05: Effect of "Additional Shear Strain Layer" on Mechanical Properties of Fine Drawn Wire
S. KAJINO, M. ASAKAWA, Waseda University; N. INAKAZU, Osaka Prefecture University,
E-mail: kajino@moesi.waseda.jp

Fine wires around the order of 0.1 mm in diameter have become popular for mechanical and electrical applications. In general, fine wires produced by the drawing process are required to have both high strength and high ductility. In the wire drawing process, a large shear deformation zone with a hardened layer, referred to as the "additional shear strain layer", is generated beneath the surface layer of the wire. It is expected that this layer have high tensile strength with keeping ductility because of