by the rivet head and the jointing force between the rivet axis and the plate, plastic-plastic finite element simulations of the riveting process, and disjointing and rotation tests of jointed plates, and extrusion tests of the rivet axis are carried out using three kinds of punches. The results show that the force that the plate is fastened by the rivet head is the largest when a flat type punch is used, and that the jointing force between the rivet axis and plate becomes highest when a round type punch is used. The springback of the rivet when each of the punches was used was also analyzed, and from the results a process that decreased the springback of the rivet is proposed.

ICS-05: Effect of Hydrogen Gas Environment on Fretting Fatigue Strength
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The objective of this study is to clarify the effect of hydrogen gas environment on fretting fatigue strength of materials, which will be used for the mechanical system for hydrogen utilization. It is important to take fretting fatigue into account for strength design, because many fatigue failure accidents have occurred at joints or contact parts between components. The materials used in this study were austenitic stainless steel SUS 304 and corrosion resisting aluminum alloy 60601. Fretting fatigue tests were carried out with hydrogen gas, nitrogen gas and air environment. The results obtained were summarized as follows: Fretting fatigue strength in hydrogen gas was lower than that in air for both materials. The decrease of fatigue limit was larger in aluminum alloys than in stainless steel. In the aluminum alloy, hydrogen gas environment enhanced the decrease of fatigue limit with increase in contact pressure. Tangential force coefficient was higher in reverse order of fatigue strength. The values of the coefficient at fretting fatigue limit of each environment were almost the same regardless of the environments. In the stainless steel, the appearance of fretting pit and microcrack was quite different among environments. Absorption of hydrogen was detected in contact pad fretted in hydrogen environment.

ICS-06: Fretting Fatigue Degradation Characterization in 7075-T6 Aluminum Alloy
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Fretting fatigue can produce various types of degradation; for example, pitting, scratches, fretting and/or wear tracks, material transfer, sub-surface cracking and, cracks at various angles to the surface(s). The objective of the study reported herein was to focus on the characterization of fretting fatigue degradation transitioning to cracking in a 7075-T6 aluminum alloy. This study also explored the influence of microstructure (grain size) and thickness of the material on the fretting fatigue degradation in a 7075-T6 aluminum alloy. The results show that the large grain sizes found in this material are more susceptible to fretting fatigue degradation.

MMC-01: Determining the Forming Limit Diagram of a Porous Tantalum Foam
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Over the past ten years, a novel cellular solid, trabecular metal (TM), has been developed for use in the orthopedics industry as an ingrowth scaffold. Manufactured using chemical vapor deposition (CVD) on top of a graphite foam substrate, this material has a regular matrix of interconnecting pores, high strength, and high porosity. After CVD, conventional processing has involved machining the desired parts from bulk TM disks using milling or electrical discharge machining (EDM). Milling has the drawback of wasting significant material, and coolants that are used are very difficult to remove from the metal foam substrate. EDM is time consuming, and since many desired part geometries have thin cross-sections, it is costly and wasteful. For these reasons, plastic deformation through stamping is thought of as a superior alternative to machining, but a better knowledge of the forming properties of TM is desired. In this study, a forming limit diagram for TM was obtained using 1.65 mm thick sheets. To overcome difficulties associated with inscribing circles to measure strain on the surface of a porous material, CCD cameras instead recorded the evolution of the strain states. No lubricant was used due to the cleanliness requirements for orthopedic implants.

MMC-02: Kinetic Study on Boronized Duplex Stainless Steel
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Boronizing is well known in enhancing wear resistance of ferrous and non-ferrous alloys. The most relevant element of the thermochemical process is the production of very hard layers that can reach a hardness of exceeding 2000 HV, promising a better strength to friction wear and abrasion compared to carburizing and nitriding. Meanwhile, duplex stainless steel (DSS) with mixed microstructure of ferrite and austenite guarantees higher resistance to pitting and stress corrosion cracking in comparison with other stainless steels. Its applications in industrial components such as rotors, fans, shafts and impeller blades require surface contact with other parts of the components. As the active research on boronizing was mostly focused on carbon steel and austenitic stainless steel, in this work, the feasibility and potential of boronizing on duplex stainless steel was studied. Boronizing treatment was done on duplex stainless steel with the average grain size of 5μm. The DSS was boronized in Ekabor-2 powder pack at 1123 K, 1173 K and 1223 K for 1, 2, 4 and 6 hours. The boronized layer formed has a compact and smooth morphology. Depending on boronizing time and temperature, the boride layer thickness ranged from 8 to 38.2μm. The surface hardness of DSS increases remarkably up to 2601 HV. By measuring the boride layer thickness, kinetics of atoms in this study was determined using the Arhenius relation, and it was shown that boron growth rate constant, K increases with boronizing temperature with values ranged from 1.03 x 10^{-14} to 5.44 x 10^{-14} m^2 s^{-1}. The activation energy, Q was determined as 192.1 kJ mol^{-1}. The results for this kinetic study were in good agreement with the literatures.

MMC-03: Anodic Bonding and its Interfacial Reaction between Metals and Ionic Conductor
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Anodic bonding is one of low temperature bonding method, which is applying electric field. The anodic bonding was attempted using β-alumina, partially stabilized zirconia (YSZ) as ionic conductor and pure aluminum (Al) and silver (Ag) as metal. In Al/YSZ system, the bonding succeeded under the constitution above 573K in temperature and 50V in voltage. As increasing bonding temperature and voltage, the bonding strength increased. Amorphous like structure with Al, Zr, Y and O were observed in the interface between YSZ and Al. In Ag/YSZ system, the bonding succeeded in 473K. Around the interface, the diffusion of Ag in YSZ and the reaction products Ag2O were observed. It seems that the bonding is promoted by the molding of diffused Ag to gap of YSZ and Ag. In Al/β-alumina, the bonding succeeded only under the condition of 673-773K in temperature and 75V in voltage. The bonding strength was week, which was only several MPa. Bonded areas was very narrow but the fracture was occurred in β alumina.