Modelling Of Fine Blanking Process

Sunil B.Mate[1]
[1]Department of Production Engineering
[1]VJTI, Matunga, Mumbai-400 019

Abstract— During the past decade, one clear trend has been observed in the production of metal components. That is every industry work hard to minimize the time required to launch the new product in the market and reduce the cost of operation to maximize profit. As blanking process is the most widely used separation technique in the world but the analysis of blanking process is not done up to that instinct. And also in present day product should be dimensionally so accurate produced by blanking processes, hence it is necessary to study the factors or parameter which are directly or indirectly affect the dimensional tolerance of the blanking product. Metal blanking is a widely used process in high volume production of sheet metal components but after blanking, burr formation at edges of the product is observed and it is not match with the close dimensional tolerance and hence it is need to do the debarring process which is increasing the cost of production and time require for production. Fine blanking is process which helps us to minimize the burr size and like conventional blanking process there are so many parameter which influence the burr height of the product so our main objective of this is to develop a model to predict optimum value of such parameter which influence the burr height of product in fine blanking process and developed the model. The model investigates the effect of potential parameters influencing the blanking process and their interactions. This helped in choosing the process leading parameters for two identical products manufactured from two different materials blanked with a reasonable quality on the same mold.

Keywords: Blanking, FME, DOE, Burr height

I. INTRODUCTION

Blanking Process- in this era of competition many products are manufactured by blanking process from small part of watches to heavy machinery. Blanking is defined as the cutting of a work piece between two die components to a predetermined contour by applying the force on the punch. During blanking, the part is going to various stages such as deformation, hardening and crack initiation and propagation. The theoretical explanation of such a complex model is very difficult to explain because the product is going through the elastic deformation to plastic deformation and at the end total separation of the sheet metal.

During the blanking process material going through the various phases and mainly divided into the 5 stages initially material are pushed into the Dia cavity during this process the material initially deform elastically after as force increases elastic deformation turn into the plastic deformation and after inter stress cross the ultimate stress value of the material neck formation start at the weakest section causing the fracture of the material, due to elastic deformation of the material burr are generated .In most of the case of blanking ductile facture occur after the shear deformation.

Metal blanking is a commonly used process in the most of the industry in which high volume production of metal components are produced. As the close dimensional accuracy is the most important parameter in today era with less production time to achieve this is very difficult because here is no general guideline for designing the die for blanking process hence to design the blanking process in industry it is still based largely on trial and error method and it is often time consuming and expensive. so to overcome to with this problem there is need to develop the method which reduce the trial and error method. Therefore, appropriate modeling and understanding of the blanking process could be beneficial to reduce the lead-time and to control the product specifications, especially the shape of a blanked (sheared) edge.

II. PROBLEM DEFINITION

Blanking process is widely used in the industry but after completing the banking process it needs the various kinds of finishing operation which leads to high cost of production and higher lead time. So to overcome with this problem we used the fine blanking technique is the effective technique, with this we can reduce the effort required for finishing process. But as we know the fine blanking process is not widely used hence no optimization done yet so we try to optimize the fine blanking process by using the simulation technique.

III. OBJECTIVE AND SCOPE

Every industry tries to improve their manufacturing process to increase the productivity and reduce the cost by altering the process and adopting the new technique of manufacturing. Fine blanking technique gives the scope to the industry to do so. Since there is not much of optimization of the process done yet it need expensive tool to perform the fine blanking so our aim to optimize the process by varying various parameter of the process so that the optimum value of this parameter is known to us which will help to reduce the operation cost of the process.

IV. LITERATURE REVIEW

Numerical simulation related to the sheet metal problems can be solve by using finite element method(FEM) which help us to reduced trial and error for optimizing the process. Although process modeling using FEM simulation is already used in industry in a wide variety of forming operations, no commercially available. FEM code is capable of simulating, with the required degree of precision, the blanking process, and fracture formation. As the die-punch clearance increases The shear droop on products punched by the fine blanking process was confirmed to become greater[7].The sheet-blanking operation can be optimization and analyzed using the finite-element technique by using analyzing software. Blanking process mainly depend upon the value of stress generated in sheet metal. The effect of various parameters such as punch to die clearance, material of sheet metal, and thickness of sheet metal and shape of the punch used for blanking can be studied by using FEM technique [5]. Effect of the various parameters such as clearance, metal thickness, and material on burr formation can be studied [6].Clearance play an important role in the blanking process proper clearance not only improves the quality product but also reduce the burr size and also increase the punch and die life by reducing the punch and die wear, also punching time play an vital role higher punching time increases friction reducing the quality of product and increasing wear of die and punch [1]Mechanical characteristics of the blanking process are affected by different parameters factors affecting in the blanking process like the A. Clearance B. tool wear C. Sheet Thickness D. Material E. Punch geometry [4]. Holding force can be one factor which can be under consideration while doing the optimization v ring indenter improve the quality of the product [3] BY using FEM we can calculate the optimum values of the clearance for a particular sheet metal thickness and material in the absence of this number of experiments has to performed to find out the optimum vale [4]. A literature on the blanking process shows that while a large number of analytical techniques have been used to study the process, the amount of theoretical and practical work done is relatively insufficient and thus further investigation is still needed. One reason for this may be the difficulty of simulating the shearing process because of the narrowness of the shear band formed and the lack of an appropriate fracture criterion. The most recent studies in the field of manufacturing processes show that, despite the increasing progress in blanking process analysis, there is still a lack of models allowing for the optimal design of sheet metal shearing processes.

IV. BLANKING PROCESS AND FINE BLANKING

Blanking Process-Blanking is commonly used technology in the industry. Its applications range from components of very light to heavy appliances and machineries. Blanking is a metal fabricating process, during which a metal work piece is removed from the primary metal strip or sheet when it is punched. The material that is removed is the new metal work piece or blank. Characteristics of the blanking process include:

Its ability to produce economical metal work pieces in both strip and sheet metal during medium or high production processes, The removal of the work piece from the primary metal stock as a punch enters a die, The production of a burnished and sheared section on the cut edge, the production of burred edges, The control of the quality by the punch and die clearance, The ability to produce holes of varying shapes – quickly.

The blanking process forces a metal punch into a die that shears the part from the larger primary metal strip or sheet. Like many other metal fabricating processes, especially stamping, the waste can be minimized if the tools are designed to nest parts as closely together as possible.The blanking process has some downside effects. These include:

Generating residual cracks along the blanked edges, Hardening along the edge of the blanked part or work piece, and Creating excess roll-over and burr if the clearance is excessive. The most common materials used for blanking include aluminium, brass, bronze, mild steel, and stainless steel. Due to its softness, aluminium is an excellent material to be used in the blanking process. Tooling is typically made from tool steels and carbides, with the carbide tooling used for higher production runs and intricate punched shapes. A blanking die consists of a single, or multiple, pairs of mating dies. Tools are expensive for blanking so it is critical that the tooling be created correctly holding tolerances while minimizing scrap.

Fine blanking- Fine Blanking, is alternative for the conventional blanking a precision mass production technique, is a unique development in the metal forming industry, occurring over the last eight decades. Its conception, although innovated from traditional metal stamping techniques employ

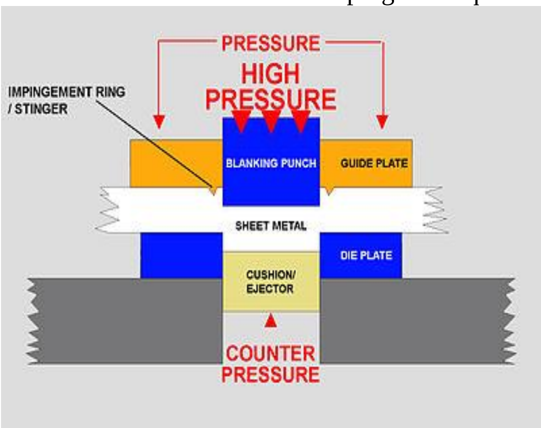


Fig.1: Schematic Dia of fine blanking

Entire different methods are employed during the fine blanking for the tolling and punch. With the use of the fine Banking technique we can achieve close dimensional tolerance with the minimum cost and less time. Fine blanking is a technique I which there no facture during sharing this is achieve by using the counter punch places below the sheet metal and applying the counter force to produced compressive action. This type of process allows very tight operation removes the further finishing operation Materials that can be fine blanked include aluminium, brass, copper, and carbon, alloy, and stainless steels, basically fine blanking is used in the automobile industry for manufacturing high precision part of the engine door, latches and part of watches etc. Capability of fine blanking process to produces the close dimension product making this process popular in many industries.

V. METHODOLOGY

The methodology that is followed to attain the research objectives is divided into the following work phases:

A. Classify the blanking parameters into controllable and uncountable. The identified controllable parameters are clearance, blank holder force, sheet metal thickness, and material.

B. While, the uncountable parameters are material prosperities inconsistency and conditions (shape, defects and internal stresses), friction and wear state of the tool, stroke rate or blanking speed, and punch-die alignment. After completing the simulation we are going the to perform the iteration to get optimize value.

Finite Element Method (FEM) and Design of Experiments (DOE) techniques are used to achieve the study objectives. The combination of both techniques is proposed to result in a reduction of the necessary experimental cost and effort in addition to receiving a higher level of verification. Design of Experiments provides the guidance in the selection of the proper combination of the process parameters at their specified levels, in such a way that costly dies will not be manufactured until the finite element simulations show the best set of process parameters

VI. RESULTS AND DISCUSSION

Simulation- We had built the model in ansys by using axis symmetrical method. In this we had taken the a punch of radius 9.95mm,9.90mm,9.85mm for clearance 0.05mm,0.1mm,0.15mm respectively. The sheet which has to be blank is taken as 0.5mm, 0.6mm and 0.7mm thickness. We use the three type of material for iteration that is s304, aluminum and copper. We use the punch holding force as 0N, 1000Nand 3000N.In the annoys we convert that BHF force into the pressure by using formula of sheet metal
Pressure= (force/area)

We use punch displacement for the cutting purpose instead of applying the pressure we use fix support for the holdings the sheet for analysis process. Initially we apply the 0 back pressures so to evaluate burr height in conventional blanking later on we increase the back pressure and other parameter to optimizing the process. So by combining this four parameter we get 81 combination of parameter for simulation.

For simulation we use the0.035mm mesh size after successfully meshing we get 5545 nodes and 5177 elements for of 0.5 mm thick sheet

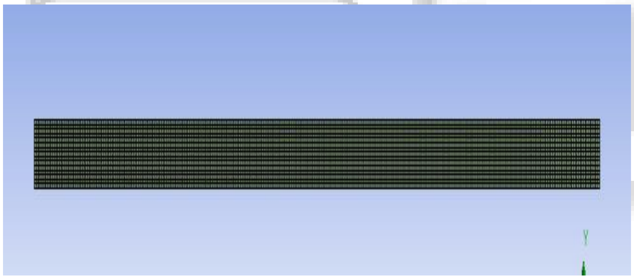


Fig. 2: Meshing of sheet

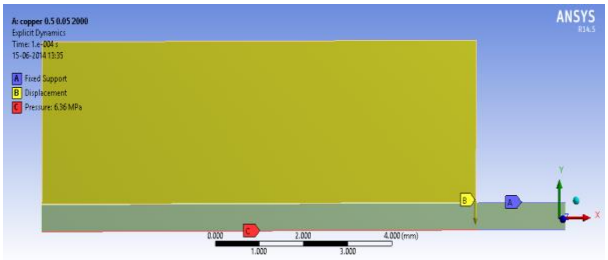


Fig. 3: Model design for explicit dynamic

A. SIMULATION PARAMETER

In this experiment we have selected four parameter that affecting the burr height are as follows

- Punch to die clearance
- Material thickness
- Material of sheet
- Blank holding force

This parameter makes a direct impact on burr height so we study the effect of this parameter on the burr height. After performing the simulation successfully we get numerous data by using met lab software we analyse this data and study the effect of above mentioned parameter on burr height

B. Effect of clearance:

As we see in the graph as the clearance increase from 0.05mm to 0.15mm the height of the burr is also increase this because as the clearance increases it gives more space for the material to flow. Hence we get minimum burr height on the 0.05 mm clearance

C. Effect of Thickness:

In the graph we can see as the thickness of sheet metal increases from 0.5 to 0.6 the burr height increases but as thickness increases from 0.6 to 0.7 it increases marginally so we can conclude that burr height increases with sheet thickness and we get minimum value at 0.5mm thickness.

D. Effect of Blank Holding Force:

BHN Is a very important factor in this simulation technique as we see in the chart it is clearly seen that as the BHN changes from the 0 to 1000N the burr height reduced drastically this is just because
Of the blank holding force which is opposite in punch force do not allow the metal sheet to bucking during the punching process leading to smaller burr height.

E. Effect of the Material used:

AL those this is not important factor among other because selection of material is mainly depend upon the type of use still we are studding the effect of material on burr height.as we see in the graph it is clearly seen that burr height is minimum for the ductile material like cooper and it is higher for ss304.As we see in the graph the effect of punch clearance, thickness of sheet metal and BHN on burr for ss304, copper and aluminium, respectively. After successfully simulating 81 combination of blanking process parameter we got the following results

ss304						
Sr no	clearance	thickness	BHF IN N	Burr height	%	maximum stress
1	5	0.5	0	0.095238095	19.04761905	1167
2	5	0.5	1000	0.076086957	15.2173913	1167.9
3	5	0.5	2000	0.076923077	15.38461538	1174
4	5	0.6	0	0.12	20	1162.1
5	5	0.6	1000	0.114705882	19.11764706	1165.6
6	5	0.6	2000	0.096774194	16.12903226	1172
7	5	0.7	0	0.143181818	20.45454545	1171.4
8	5	0.7	1000	0.12962963	18.51851852	1170.5
9	5	0.7	2000	0.116666667	16.66666667	1164
10	10	0.5	0	0.108695652	21.73913043	1148.9
11	10	0.5	1000	0.097826087	19.56521739	1138.3
12	10	0.5	2000	0.089285714	17.85714286	1147.2
13	10	0.6	0	0.109090909	18.18181818	1155.2

14	10	0.6	1000	0.104347826	17.39130435	1168
15	10	0.6	2000	0.103846154	17.30769231	1152.2
16	10	0.7	0	0.143478261	20.49689441	1149
17	10	0.7	1000	0.134615385	19.23076923	1152.5
18	10	0.7	2000	0.125	17.85714286	1160
19	15	0.5	0	0.095238095	19.04761905	1151.1
20	15	0.5	1000	0.089285714	17.85714286	1151.8
21	15	0.5	2000	0.086538462	17.30769231	1144
22	15	0.6	0	0.116666667	19.44444444	1141.7
23	15	0.6	1000	0.111111111	18.51851852	1146
24	15	0.6	2000	0.108	18	1155
25	15	0.7	0	0.175	25	1148.7
26	15	0.7	1000	0.145833333	20.83333333	1150.8
27	15	0.7	2000	0.128333333	18.33333333	1154

Table. 1: Burr height for ss304

Copper						
Sr no	clearance	thickness	BHF IN N	Burr height	%	maximum stress
29	5	0.5	1000	0.08	16	449.76
30	5	0.5	2000	0.034482759	6.8965518	449.52
31	5	0.6	0	0.0875	14.58333333	449.97
32	5	0.6	1000	0.077142857	12.85714286	449.7
33	5	0.6	2000	0.054545455	9.090909167	449.96
34	5	0.7	0	0.12962963	18.51851852	449.99
35	5	0.7	1000	0.096551724	13.79310345	449.99
36	5	0.7	2000	0.073684211	10.52631586	449.83
37	10	0.5	0	0.075757576	15.15151515	450
38	10	0.5	1000	0.068965517	13.79310345	449.8
39	10	0.5	2000	0.05	10	449.98
40	10	0.6	0	0.1	16.66666667	449.92
41	10	0.6	1000	0.08	13.33333333	449.98
42	10	0.6	2000	0.07	11.66666667	449.96
43	10	0.7	0	0.144117647	20.58823529	450
44	10	0.7	1000	0.116666667	16.66666667	450
45	10	0.7	2000	0.096551724	13.79310343	450
46	15	0.5	0	0.086206897	17.24137931	449.93
47	15	0.5	1000	0.083333333	16.66666667	449.95
48	15	0.5	2000	0.06	12	449.51
49	15	0.6	0	0.113513514	18.91891892	449.9
50	15	0.6	1000	0.094285714	15.71428571	449.95
51	15	0.6	2000	0.09375	15.625	449.96
52	15	0.7	0	0.14	20	449.98
53	15	0.7	1000	0.125	17.85714286	450
54	15	0.7	2000	0.1125	16.07142857	449.99

Table. 2: Burr height for Copper

Aluminium						
Sr no	clearance	thickness	BHF IN N	Burr height	%	maximum stress
55	5	0.5	0	0.076923077	15.38461538	290
56	5	0.5	1000	0.0658	13.33333333	290
57	5	0.5	2000	0.034482759	6.818181818	290
58	5	0.6	0	0.1	16.66666667	290
59	5	0.6	1000	0.0854	12.5	290
60	5	0.6	2000	0.054545455	9.722222222	290
61	5	0.7	0	0.12	17.14285714	290
62	5	0.7	1000	0.102	11.9047619	290
63	5	0.7	2000	0.073684211	10	290
64	10	0.5	0	0.08	16	290
65	10	0.5	1000	0.075	14	290
66	10	0.5	2000	0.05	13.04347826	290
67	10	0.6	0	0.103846154	17.30769231	290
68	10	0.6	1000	0.09766	16.66666667	290
69	10	0.6	2000	0.096774194	16	290
70	10	0.7	0	0.128333333	18.33333333	290
71	10	0.7	1000	0.1235	17.1875	290
72	10	0.7	2000	0.096551724	16.66666667	290
73	15	0.5	0	0.106060606	21.21212121	290

74	15	0.5	1000	0.1021 03	20	290
75	15	0.5	2000	0.0965 51724	15.217 3913	290
76	15	0.6	0	0.1384 61538	23.076 92308	290
77	15	0.6	1000	0.1256	18.918 91892	290
78	15	0.6	2000	0.0937 5	16.129 03226	290
79	15	0.7	0	0.1633 33333	23.333 33333	290
80	15	0.7	1000	0.1565	20.833 33333	290
81	15	0.7	2000	0.075	16.666 66667	290

Table. 3: Burr height for Aluminium

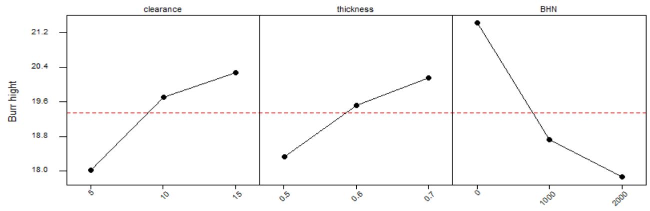


Fig. 4: .Main effect plot for ss304

For ss304 optimum burr height is obtained at 0.05mmclearance with 0.5mm thickness of sheet with 2000N BHF**.** I.e. 0.076923077 (15.38461538% of thickness)

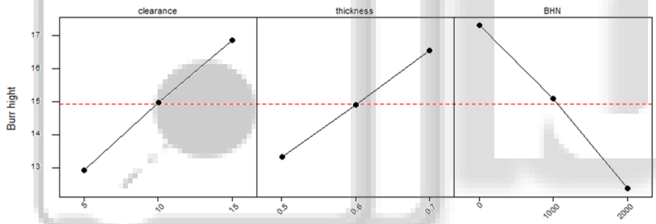


Fig. 5: Main effect plot for cooper

Similarly for copper optimum value of burr height is obtained at 0.05mm punch clearance, 0.5mm thickness of sheet metal with 2000 BHF I.e. 0.058333333 (11.66666667% of sheet metal thickness).

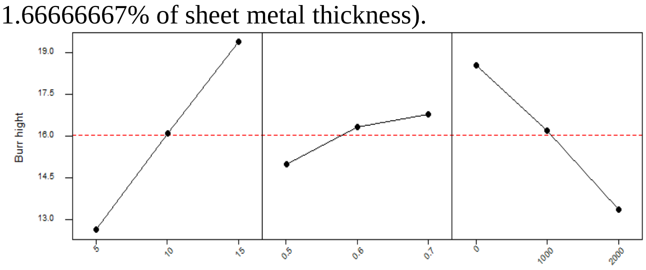
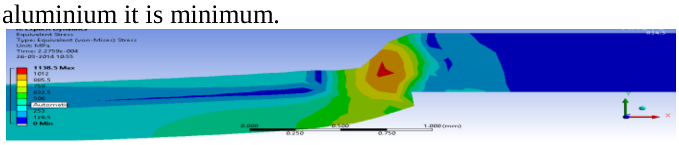


Fig. 6: Main effect plot for aluminium

Similarly for aluminium optimum value of burr height is obtained at 0.05mm punch clearance, 0.5mm thickness of sheet metal with 2000 BHF I.e. 0.034090909 (6.818181818% of sheet metal thickness). From above graph we can easily concluded that optimum burr height for above simulation is obtained at 0.05mm punch clearance, 0.5mm thickness of sheet metal with 2000 BHF and or aluminium it is minimum.



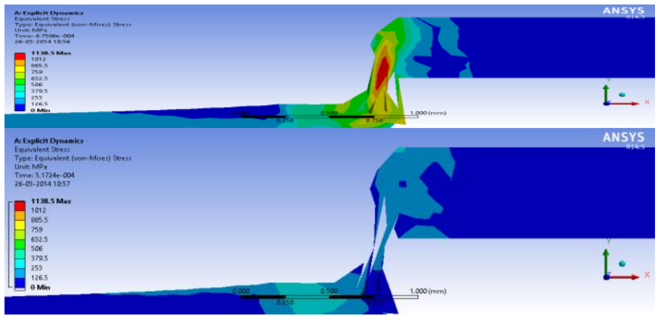


Fig. 7: Step in banking process

VII. CONCLUSION

In the present work factors affecting in the blanking process are clearance, tool wear, sheet thickness, material and punch geometry. Also the basic difference between blanking and fine banking process is blank holding force. FEM and Design of Experiments are identified as a approaches to study the effects of these parameters on the height of burr formed during punching. After successfully completing the simulation we can conclude that optimum burr height for above simulation is obtained at 0.05mm punch clearance, 0.5mm thickness of sheet metal with 2000 BHF for aluminium.

REFERENCES

[1] The optimal clearance design of micro-punching die by J.Ch. Lin, W.S. Lin, K.S. Lee, J.L.
Department of Mechanical Design Engineering, National Formosa University, 64 Wunhua St., Huwei, Yunlin, Taiwan
Department of Mechanical and Computer-Aided Engineering, National Formosa University, 64 Wunhua St., Huwei, Yunlin, Taiwan
Department of Mechanical Engineering, Chien Kuo Technology University, Changhua, Taiwan. (Journal AMME VOLUME 29 ISSUE 1 July 2008)

[2] An Overview of Clearance Optimization in Sheet Metal Blanking Process by Prof. T. Z. Quazi, R.S.Shaikh, Department of Mechanical Engineering, Mumbai University, India(JJMIE Volume 2, Number 1, Mar. 2008 ISSN 1995-6665 Pages 53 -63)

[3] The effect of V-ring indenter on the sheared Surface in the fine-blanking process of pawl byT.S. Kwak, 2) Y.J. Kima, 3) M.K. Seo, 4) W.B. Baeb, Graduate School, Pusan National University, Busan, South Korea
School of Mechanical Engineering, Pusan National University, Busan, South Korea (Journal of Materials Processing Technology 143–144 (2003) 656–661)

[4] An Overview of Factors Affecting In Blanking Processes by 1)Amol Totre,2)Rahul Nishad, 3)Sagar Bodke(International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 3, March 2013)

[5] FINITE-ELEMENT ANALYSIS OF THE BLANKING PROCESS by
P.B. POPAT Mechanical Engineering Department, L.E. College, Morbi, Gujarat (India)

A. GHOSH and N.N. KISHORE Mechanical Engineering
Department, Indian Institute of Technology, Kanpur (India) (Journal of Mechanical Working Technology, 19 (1989) 251-259)

[6] An Application of Finite Element Method and Design of Experiments in the Optimization of Sheet Metal Blanking Process by Emad Al Momani, Ibrahim Rawabdeh , Industrial Engineering Department, University of Jordan, Amman, Jordan(JJMIE Volume 2, Number 1, Mar. 2008 ISSN 1995-6665 Pages 53 - 63)

[7] Analysis of Shear Droop on Cut Surface of High-Tensile-Strength Steel in Fine-Blanking Process by Toru Tanaka, Seiya Hagihara, Yuichi Tadano, Shuuhei Yoshimura, Takuma Inada, Takanobu Mori and Kenji Fuchiwaki4
(Materials Transactions, Vol. 52, No. 3 (2011) pp. 447 to 451 #2011 The Japan Society for Technology of Plasticity)

