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R dacteurs : P. Lamesle, L. Penazzi **Date : 01/03/02**

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- **0 : pour 2002**
- **4 : pour 2001**
- **10 : pour 2000**
- **9 : pour 1999**
- **8 : pour 1998**
- **4 : pour 1997**

4 : pour 1996

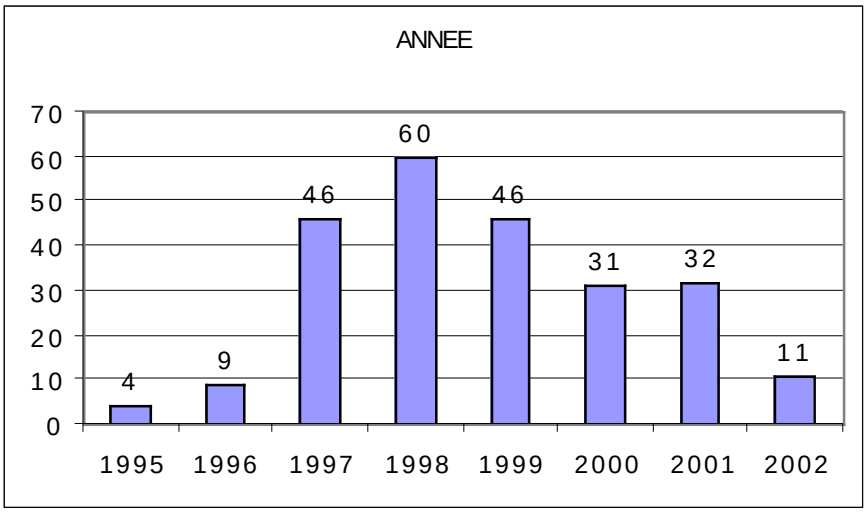
3 : pour 1995

Un r sultat exceptionnel

Ce r sultat mensuel exceptionnel de **42 r f rences cit es** , est du la **mise en ligne des publications d'Elsiever** ce qui a permis la prise en compte d'articles parus depuis 1995, ainsi que l'utilisation de r f rences provenant de **la veille 2000-2001 sur les traitements de surface**.

Avec l'arriv e de ces titres, ce sont maintenant 243 r f rences qui sont enregistr es dans la base OIO emboutissage-d coupage avec 60 pour l'ann e 1998 (Figure 1).

Figure 1 : Répartition annuelle des publications concernant les outils d'emboutissage-découpage.



Brevets (0)

N ant

Publications (44)

95-02 Navinek B.,Panjan P.,,,Novel applications of CrN (PVD) coatings deposited at 200¡C,Surface and Coatings Technology,74-75,2,October 1995,919-926,1995

CrN (PVD) coatings, deposited at 200¡C in plasma beam sputtering apparatus, were used for selected applications in industry. Using CrN coating, we improved two types of tool: moulds for Al alloy die casting (made of AISI H11 tool steel) and cold forming tools (made of AISI D2 and D3 tool steel). For the first group of tools, it was important that the CrN coating could be successfully used as a hard, oxidation- and corrosion-resistant coating at working temperatures of up to 800 ¡C; for the second group of tools, the low tempering temperature dictates deposition at 200¡C. The tool life, surface quality of the products and wear mechanisms were studied for the following polished tools (max. diameter, 210 mm): a mould for Al-Si12 die casting of small components of compressors; a combined cold forming and cutting die for mass production of covers for the heating plate of an electric stove; a cold forming deep drawing die for the production of a halogen lamp housing in the electric light industry; a tool set for automatic gradual deep drawing of fancy goods for the shoe and leather industry; a deep drawing die for mass production of the covers of electric motors. All the results

show that a CrN coating 4.5-5.5 m thick with a Cr intermediate layer 0.2 m thick between the substrate and the coating improved the technological processes and resulted in a noticeable improvement in performance tests. Increased tool life, a higher quality of surface finish of the products and high reliability of CrN coated tools in production were regularly observed during long-term performance tests.

95-03 Curtins H.,PLATIT : A new industrial approach to cathodic arc coating technology,Surface and Coatings Technology,76-77,2,December 1995,632-639,1995

Cathodic arc technology has, in the past, suffered from a number of severe problems when implemented in industrial production environments, despite its undisputable basic physical advantages for the deposition of functional hard coatings. The disadvantages concern, in particular, the following fields: insufficient control of the arc source (rate, target poisoning, target erosion, arc stability), unsatisfactory process control (temperature control, mixing of tools with different sizes and dimensions), poor film structure (droplet formation, columnar growth), poor reproducibility of main film parameters, still too high cost of operation (maintenance, cleaning, etc.), and lack of complete automated process control. Within the PLATIT concept a new type of arc source has been developed, capable of overcoming most of these limitations. Together with dedicated process control in a new coating system, good results can be obtained under industrial production conditions for a variety of applications. Special emphasis was put on reducing internal film stresses for TiN and TiCN coatings. In this way, films up to 20 m thick could be deposited. Thick coatings (approximately 8 m) applied on punching and deep-drawing dies show considerable increases in performance never attained so far. A completely automated coating system permits the reproducible deposition of complex him structures and multi-layers in a very economical way. The PLATIT system has proved to satisfy the requirements of high quality combined with high productivity for cutting tools as well as the criteria of compactness and low droplet density for mould injection tool applications.

PVD hard coatings; Arc technology; Cutting tools; Ti based coatings; Wear resistant coatings

95-04 Min Dong-Kyun ,Jeon Byung-Hee ,Kim Hyung-Jong ,Kim Naksoo ,A study on process improvements of multi-stage deep-drawing by the finite-element method,J. of Mat. Proc. Technology,54,1-4,October 1995,230-238,1995

Multi-stage deep-drawing processes, including normal drawing, reverse drawing, and redrawing, to shape the front shell of a master VAC for an automobile have been analyzed sequentially by the use of the rigid-plastic finite-element method, computational results on the punch/die loads and thickness distributions being obtained. The thickness strains were compared with the results of experiments on current drawing processes, good agreement being found. Deep-drawing processes of the redesigned shell to improve the specific strength and stiffness were simulated with the numerical method developed. By varying several process parameters, such as the blank size, the corner radii of the tools, and the clearances, the simulation results showed improvements in reducing the forming loads. Also, forming defects were found during simulation and the appropriate blank size could be verified.

96-07 Shulkin Leonid,Jansen Steven W.,Ahmetoglu Mustafa A.,Kinzel Gary L., Altan Taylan,Elastic deflections of the blank holder in deep drawing of sheet **metal,J. of Mat. Proc. Technology**,59,1-2, 15 May 1996,34-40,1996

96-08 Wong P. K.,Leung T. P.,Chuen C. W.,,Object-Oriented CAD for Practical Hydraulic System Design,**Engineering Applications of Artificial Intelligence**,9,5, October 1996,499-514,1996

96-09 Gunnarsson L.,Asnafi Nader,Schedin Erik,,In-process control of blank holder force in axi-symmetric deep drawing with degressive gas **springs,J. of Mat. Proc. Technology**,73,1-3, January 1998,89-96,1998

A new blank-holder system with degressive gas springs has been developed and evaluated for axi-symmetric deep drawing. In contrast to most published works in this field, in which hydraulic systems are utilized, the new system is integrated with the tool body instead of with the press, the advantage with this approach being that the system is independent of press facilities. The new system consists of inter-connected active and passive gas springs, moving parallel during forming. With the new system, degressive, constant and progressive blank-holder force (BHF) trajectories can be obtained. The BHF-trajectories were pre-determined with a specially developed software. Two materials, an ordinary deep drawing steel and a high-strength rephosphorized steel, have been analysed. The thickness was 0.7 mm and a water emulsion was used as lubricant. The blank holder force, punch force, total force and the separation of the blank holder (wrinkle detection) were recorded continuously during the pressing operation. With a degressive BHF-trajectory the process window between fracture and wrinkling in axi-symmetric deep drawing is larger compared to those obtained with constant and progressive trajectories, and also, the LDR is higher.

96-10 Snieckers J.N.F,Friction in deep drawing,, PhD thesis report, University of Twente,1996

97-38 Cl dat P.,Machet J.,,,Growth mechanism study of TiN coatings obtained by vacuum arc evaporation,**CIP'97 Proceeding - 11th International Coll.,**133-136,1997

Titanium nitride films were deposited onto AISI D2 steel discs using a conventionnal vacuum arc evaporation process. The main deposition parameters, i.e. substrate temperature, Ts, substrate bias voltage, Vs and nitrogen pressure PN2 are varieted independently from each other. The aim opof this work was to understand the evolution of mechanical of the films, considering the variation of microstructural properties, such as stress level and grain size in function of each deposition parameter.

97-45 Sing W. M.,Rao K. P.,,,Knowledge-based process layout system for axisymmetrical deep drawing using decision tables,**Computers & Industrial Engineering**,32,2, April 1997,299-319,1997

In practice, the success of even a very simple single-stage sheet metal drawing depends on the tool designer's experience. Intelligent computer aided process planning (CAPP) is an ideal tool to reduce design time, increase productivity, and design the die without too much reliance on human expertise. In this present computer aided process planning for deep drawing, the required finished part is input to the system, and the output is a set of highest feasible forming process parameters for the purpose of die design. A decision table provides a means to link the numerous decision factors with recommendations in a complete and non-redundant manner. The logic rules contained within a decision table can be a number of production rules, fuzzy set and frame as well. The decision table, which is an easily understandable logic representation method

even for complex situations, has been implemented in the present CAPP for deep drawing process.

97-48 Doege E.,Dr der K.,,,Pressing of sheet steel using ceramic dies, **Bander Bleche Rohre**,38,12,,16-18,1997

More efficient tooling material with suitable properties will have to be utilized for improved forming of high strength steels or non-ferric alloys with simultaneous reduction of lubricant usage. In this regard, the use of ceramic materials as an insert for strongly abraded areas in large tools or as a all-ceramic active part for small incremental or follow-up composite tool has received increased interest. In initial experiments for the suitability of ceramic materials as drawing dies, forming experiments were performed with a drawing die of silicon nitride. The drawing ring resisted the forces of the drawing process with any additional constructive measures (such as armoring). The upper die force could be reduced by 6% in comparison with values obtained with a polished hard metal drawing ring. Additional deep draw tests without the use of lubricants resulted in a decrease of the upper die force by 23%.

97-49 Cao J.,Boyce M.C. , A predictive tool for delaying wrinkling and tearing failures in sheet metal forming,**Journal of Engineering Materials and Technology**,119,4,354-365,1997

In the sheet metal forming industry, there is increasing demand to lower manufacturing costs while also providing a decrease in product development turnaround period and lighter weight products. These demands have put increasing pressure on the development and use of predictive numerical simulations and in the design and optimization of new forming technologies. In this paper, two of the primary in-process failure modes of sheet metal, wrinkling and tearing, are examined followed by construction of an advanced forming technology, variable binder force, using numerical tools. Specifically, a methodology of capturing the onset of wrinkling and postbuckling behavior proposed in cao and boyce (1997) is used to predict wrinkling failure in conical and square cup forming. The results obtained from simulations and experiments demonstrate that the proposed method is not only accurate, but also robust. A tearing criterion based on forming limit diagrams of non-proportional loading paths is then developed and again shot

98-51 Pahl Klaus-J rgen,New developments in multi-point die-cushion technology **,J. of Mat. Proc. Technology**,71,1, 1 November 1997,168-173,1998

An important and developing topic in sheet metal forming is the improvement of reproducibility of the deep drawing process. One key factor is the control of material flow by the corresponding control of the blankholder pressure. Conventional single or double-action press systems do not offer the means of adjusting a pressure profile that suits a specific part geometry in an optimal way. This causes increased tool run-in times, extended tool change times and high scrap rates for critical forming tasks. This paper describes a new generation of the multi-point-control system consisting of a hydraulic press, a multiple cylinder unit for the blankholding function and flexible forming elements as punch drive. Based on the principles of separating the blankholder function from the slide operation, a part-geometry related blankholder cylinder pattern and providing of centric loading of the forming elements, an improved process stability is achieved. The introduction of a PC-based control system using MS-Windows for the operator interface and a PLC as a software emulation ensures an easy handling of the complex parameter adjustments. An application in the field of stainless steel forming verifies the improvement of process control.

Blankholder; Tool; Drawing Index Terms: Deep drawing; Computer control; Computer software; User interfaces; Stainless steel; Pressure control; Sheet metal; Blankholder pressure; Multipoint die cushion technology

98-52 Lee S. Y.,Keum Y. T.,Chung K.,Park J. M., Barlat F.,Three-dimensional finite-element method simulations of stamping processes for planar anisotrophic sheet metals,**International Journal of Mechanical Sciences**,39,10, October 1997,1181-1198,1998.

A three-dimensional finite-element method (FEM) was developed to simulate forming processes with arbitrarily shaped tools for planar anisotropic sheet metals. An implicit, updated Lagrangian formulation based on an incremental deformation theory was employed along with a rigid-viscoplastic constitutive equation. Contact and friction were considered using the mesh-normal scheme which compatibly describes arbitrary tool surfaces and FEM meshes without depending on the explicit spatial derivatives of tool surfaces. The consistent full set of governing relationships, which includes the equilibrium equation and mesh-normal geometric constraints, was appropriately linearized. Based on membrane approximation, linear triangular elements were used to describe formed sheets. The non-quadratic strain-rate potential previously developed by Barlat et al. was employed to account for the in-plane, anisotropic properties of sheets. Numerical simulations were performed for the deep drawing of a cylindrical cup and the stamping of an automotive front fender panel to test the planar anisotropic finite element code. In the cup-drawing analysis of a 2090-T3 aluminium alloy sheet sample, the predicted earing profile and cup height were compared with experiments. The predicted and experimental thickness strains were in relatively good agreement, even though thinning trends between rolling and transverse directions were reversed. In the fender stamping analyses of both the aluminum alloys and a mild steel sheet, the numerical stability, accuracy, and usefulness of the formulation were confirmed for automotive applications. In-plane, anisotropic effects on the forming limit curves are also discussed.

Barlat's strain-rate potential; mesh-based frictional contact; aluminum alloy sheet; automotive front fender Index Terms: Stamping; Pressing (forming); Sheet metal; Aluminum alloys; Finite element method; Computer simulation; Automotive engineering; Front fender

98-53 Shimizu T.,Sano T.,,,Development of a penalty method contact algorithm and its application to a sheet forming problem,**J. of Mat. Proc. Technology**,67,1-3, May 1997,177-182,1998.

FEM analysis is becoming an important tool in the metal forming industry. Many structure analysis codes are applied to simulate metal forming processes. In these codes, the treatment of contact between tools and the work-piece is an important problem. The authors have developed a penalty method contact algorithm which can treat the contact problem and the friction problem at the same time. This algorithm is incorporated into a 3-dimensional rigid-plastic FEM code. In this code, the tool surface is expressed by a B-spline patch, which can describe smooth surfaces by few control vertices. Using this 3-dimensional code, a square cup deep drawing process is analyzed. In this analysis, 8-node isoparametric solid elements are used. Reasonable results are obtained.

Metal forming; Penalty method contact algorithm; Finite element method analysis Index Terms: Metal forming; Finite element method; Algorithms; Friction; Penalty method contact algorithm; Eight node isoparametric solid elements; Square cup drawing process

98-54 Murakawa M.,Koga N.,Watanabe S.,Takeuchi S.,Tribological behavior of amorphous hard carbon films against zinc-plated steel sheets,**Surface and Coatings Technology**,108-109, 1-3, 10 October 1998,425-430,1998

Zinc-plated steel sheets extensively used in the automotive industry, particularly on body parts which are usually produced by stamping processes, such as deep drawing and blanking, are known to often cause flakes and powdering and consequent adhesion onto the tool when used without heavy lubricants. With heavy lubricants, strong degreasing agents must be used, which is detrimental to the environment. Accordingly, in an effort to achieve deep drawing of zinc-plated steel sheets either with a very light lubricant or, better yet, with no lubricant at all, various deep drawing dies, including those coated with amorphous hard carbon coatings such as DLC (diamond-like carbon) and WC/C (hard amorphous hydrogenated carbon), were subjected to a tribological test using a ball-on-disc tribometer, as well as to a field test. These amorphous hard carbon coatings showed excellent performance in terms of basic tribological properties. Furthermore, the results of the field test, in which the work material was deep drawn with no lubrication for 5000 operations using the WC/C coating, showed that even with no lubrication the coating can effectively reduce the chance of powdering that can cause surface damage or wrinkles over the cup product, thereby prolonging the die life.

Amorphous carbon film; Deep drawing; Zinc-plated steel sheet

98-55 Thiruvarudchelvan S., Wang H. B.,Seet G.,,Hydraulic pressure enhancement of the deep-drawing process to yield deeper cups,J. of Mat. Proc. Technology,82,1=3, 1 October 1998,156-164,1998

The limiting drawing ratio of AA2410 Al-Cu alloy sheet has been increased from a value of 1.8 in uniform, anneled material to a value of 2.6 by the use of differential heat treatment. That treatment involved setting up a transient thermal gradient to give a gradient of solid solution, which the lead to a large strenth gradient after quenching and aging. Both the heat treatment and the cup drawing process were modeled to predict an optimum treatment. The finite-element modeling method was used to simulate cup drawing with material description description incluede plastic anisotropy, which is know to have a significant influence on the process.

98-57 Taube K.,Carbon-based coatings for dry sheet-metal **working,Surface and Coatings Technology**,98,1-3, January 1998,976-984,1998

This paper describes recent advances in the coating of tools for forming processes such as deep drawing or clinching of aluminium and stainless-steel sheets. Various carbon-based coatings, prepared by PECVD (RF and pulsed-DC mode) and by reactive DC magnetron sputtering have been investigated with respect to hardness, abrasive wear resistance, adhesion properties and tribological behaviour under forming conditions. The softer and less wear-resistant coatings exhibited the lowest adhesive wear and friction against aluminium and stainless-steel counterparts. Application tests with coated tools were carried out under near production conditions. Correlation of mechanical test results with the film behaviour under service shows that for the dry forming of stainless steel, a high abrasive wear resistance of the hydrocarbon coating is necessary. No cold welding of the steel sheets on the tools was found, so the aim of dry working is reached by these coatings. For forming of aluminium, only softer a-C:H coatings showed satisfying anti-galling properties. In particular, in the case of aluminium working with a high degree of form change, there is a need for coatings with further improved anti-galling properties.

Sheet metal working; Tools; Coating; Thin films; Diamond like carbon; Carbon-based coatings; Hardness; Friction; Wear; Galling; Aluminium; Stainless steel

98-58 Mamalis A.G.,Manolakos D. E.,Baldoukas A. K.,,Simulation of sheet metal forming using explicit finite-element techniques: effect of material and forming characteristics; Part 1. Deep-drawing of cylindrical cups,**J. of Mat. Proc. Technology**,72,1, 1 December 1997,48-60,1998

The use of the explicit non-linear finite element (FE) code DYNA 3D in sheet metal forming simulation is examined. A 3D FE model for the deep-drawing of cylindrical cups was constructed and the simulation results obtained using different simulation parameters, i.e. punch velocity, sheet material density, Coulomb friction coefficient at the toolłblank interfaces and type and dimensions of the FE mesh-elements, compared with experimental results regarding strain distributions (radial, circumferential and thickness through the sheet) and punch forcełpunch travel curves carried out on five galvanised steels and an aluminium sheet, for three different geometries of axisymmetric cup: Good agreement was obtained. The evaluation of the CPU time cost, the macroscopic deformation modes, the strain distributions of the deformed material and the process characteristics obtained for the constructed FE models, was directed towards the selection of the most efficient material and punch parameters. Finally, an attempt was made to construct rules from the above-mentioned verification, which may be used for reliable sheet metal forming simulations, using explicit finite-element codes.

Sheet metal forming; Finite element techniques; Deep-drawing; Cylindrical cups

98-59 Cartwright D.,Drake P.R.,Godwin M.J.,,Effect of low cost press tool materials on formability of sheet steel,**Ironmaking and Steelmaking**,25,2,,131-135,1998

The trend to increase the number of vehicle model variants has led to the need for low cost press forming tooling techniques and materials.these materials represent a radical change from traditional tool materials, such as cast iron. The use of such tool materials may significantly alter the behaviour of the material being pressed. The interaction between the sheet and the tool has an effect on the amount of material flow and the level of strain in the formed panel.the results of testing low cost tool materials, with coated and uncoated sheet steel, are presented here and are compared with those obtained using a traditional tool material. The effect of each tool material on the relative level of friction is established, along with the associated change in the strain level and distribution.(author abstract).

99-26 Hurkmans, T. ; ,Kubinski, J. ,Trinh, T.,Fleischer, W. ; Van Der Kolk, G.J. ,Perspective for replacement of hard chrome by PVD,**Society of Vacuum Coaters 42nd** (1999) Annual Technical Conference Proceedings,364-367,1999

In recent years hard chromium has been replaced for specific applications with PVD films that provide equivalent or superior performance. Unlike hard chrome, PVD hard chrome replacements can be tailored specifically to the application. Coatings of CrN and variants such as CrCN exhibit properties that meet or exceed the chrome they replace, and offer additional properties, such as reduced coefficient of friction. The family of coatings known as Metal containing Diamond Like Carbon (Me-DLC, also known as Me-C:H) exhibits properties of diamond like carbon, providing outstanding wear protection, toughness and low coefficients of friction. A survey of some proven replacement applications and physical characteristics will be given. (Examples include automotive engine components, punching and forming tools, and molds and dies.)

Engine components: Coating; Machine tools: Coating; Dies: Coating; Molds: Coating; Physical vapor deposition; Diamond like carbon films: Coatings; Titanium nitride: Coatings; Molybdenum disilicide: Coatings; Chromium: Materials substitution; Abrasion resistance: Coating effects; Corrosion resistance; Diamond pyramid hardness

99-42 Schwartzentruber A. ,Bournazel J.P.,Gacel J.N.,,Hydraulic concrete as a deep-drawing tool of sheet steel, , ,**Cement and Concrete Research**,29,2,February,267-271 ,1999

To maintain the competitiveness of their products, sheet-steel manufacturers have to offer new technical innovations to reduce the costs of forming car bodies to their clients. In the current industrial process, the reduction could occur at the stage of manufacturing the deep-drawing tools used to produce about 20 to 50 prototype cars. These tools usually are made in polymer resin concrete covered by a gel coat. The use of high-performance hydraulic concrete allows us to markedly reduce production costs and simplify the process. Four types of gel-coat/concrete interfaces were tested. The best set of tools was tested on a deep-drawing line, which was able to deep-draw 16,000 parts and showed that hydraulic concrete tools covered by a gel coat can be used to produce prototype cars. Moreover, we can expect to extend their use to the production of small series of standard cars (10,000 to 20,000 parts).

High-performance concrete; Surface layer; Mechanical properties

99-43 Park S. H.,Yoon J. W.,Yang D. Y,Kim Y. H.,Optimum blank design in sheet metal forming by the deformation path iteration method,**International Journal of Mechanical Sciences**,41,10, October 1999,1217-1232,1999

Optimum blank design methods have been introduced by many researchers to reduce development cost and time in the sheet metal-forming process. Direct inverse design method such as Ideal Forming (Chang and Richmond, Int J Mech Sci 1992; 34(7) and (8): 575ł91 and 617ł33) [7, 8] for optimum blank shape could play an important role to give a basic idea to designer at the initial die design stage of the sheet metal-forming process. However, it is difficult to predict an exact optimum blank without fracture and wrinkling using only the design code because of the insufficient accuracy. Therefore, the combination of a design code and an analysis code enables the accurate blank design. In this paper, a new blank design method has been suggested as an effective tool combining the ideal forming theory with a deformation path iteration method based on FE analysis. The method consists of two stages: the initial blank design stage and the optimization stage of blank design. The first stage generated a trial blank from the ideal forming theory. Then, an optimum blank of the target shape is obtained with the aid of the deformation path iteration method which has been newly proposed to minimize the shape errors at the optimization stage. In order to verify the proposed method, a square cup example was investigated.

Optimal blank design; Deep drawing; Ideal forming theory; Path iteration method

99-45 Van Der Heide, E,Huis In't Veld, A.J.,,,Advanced surface treatments for sheet metal forming tools and their potential in non-lubricated forming operations,**Proceedings of the 10th Congress of the IFHT**: Incorporating the third ASM International Europe Heat Treatment and Surface Engineering Conference in Europe ,455-464,1999

It is well known that advanced surface treatments like chemical or physical vapor deposition, can improve significantly the lifetime of forming tools. On the other hand it is also known that the performance of a coating strongly depends on the chracteristics of the system in which it operates. Therefore, selection of possible treatments and coatings is complicated. To compare different coating-substrate combinations a new apparatus is developed on which critical contact situations during forming operations are simulated at a laboratory scale. Comparative testing of different surface treatments, under conditions that simulate industrial forming, leads to a ranking of surface treatments. This ranking depends on the used sheet material and is found under lubricated conditions. Sheet metal forming without lubricant is of current interest considering the difficulties and the costs arising form cleaning and processing the remaining lubricant and waist. The possibilities for dry forming of stainless steel are

investigated, using advanced (multi-layer) coatings on the forming tool test results under non-lubricated conditions show that Diamond-Like-Carbon coatings have potential in dry forming operations of stainless steel.

Machine tools: Coating; Diamond like carbon films: Coatings; Stainless steels: Forming; Sheet metal: Forming; Simulation; Service life: Coating effects

99-46 Katbi, K. ,Thin is in for tool coatings.,**American Machinist** ,143,10,Oct. 1999,116-118,1999

Widia Valenite (Madison Heights MI) has recently introduced multilayer chemical vapor deposition (MLCVD) which produces many (up to 2000), very thin (approx50 nm) layers of coating material. The first MLCVD product is SM245, a tool insert coating consisting of 62 layers of alternated TiN and TiCN 50 nm thick (320 nm total coating thickness) which has increased life by as much as 400% in some tests. This improved insert performance is due to superior toughness of these individual layers which substantially retards the propogation of microcracks, thereby preventing coating fractures and spalls. The smoothness of the coating minimizes friction and frictional heating. These CVD multilayers are 300 times thinner than conventional insert coatings (as discussed and described in detail in this short article). New coatings and applications are presently being evaluated including ZrCN/TiN multilayers

Machine tools: Coating; Cutting tools: Coating; Titanium nitride: Composite materials; Carbonitrides: Composite materials; Multilayers: Coatings; Chemical vapor deposition; Tool life: Coating effects

99-47 Ceschini, L.,Lanzoni, E.,Palombarini, G,.; Sambogna, G.,Frictional behaviour and wear resistance of TiN-based PVD coatings dry sliding against a TiN coated tool steel,**Metallurgia Italiana** ,91,4,,45-51,1999

The frictional behaviour and wear resistance of Ti(C,N) and TiN coatings deposited by Arc Evaporation on AISI M2 tool steel and IN 718 superalloy were studied under dry sliding conditions against a TiN coated AISI M35 tool steel.During the tests, carried out using a slider-on-cylinder tribometer at 5 N and 15 N applied loads and 0.3 m/s sliding speed for distances up to 10 km, both the coefficient of friction and the displacement between the counterfacing bodies were continuously recorded.The wear was evaluated at the end of each test by measuring the maximum depth of the wear tracks on both slider and cylinder with a stylus profilometer.The tribological behaviour of the coated materials was discussed and explained on the basis of composition, mechanical stability and shear strength of the third-body forming between the counterfacing components.

Tool steel; Friction; Wear resistance; Titanium carbide; Titanium nitride; Deposition; Tribology; Composition effects; Protective coatings

99-48 Cederquist, S.C.,Advance leads to new diamond coatings applications,**Materials Performance**,38,6,,21-23,1999

A significant advance in producing wear-resistant coatings has been achieved by scientists at the US Department of Energy's Sandia National Laboratories (SNL)(Albuquerque, New Mexcio) through the discovery of a stress-free amorphous (noncrystalline) diamond thin film material that has many of the same properties as its crystalline diamond cousin. The stress-free amorphous diamond coating is harder than any other known coating, with the exception of crystalline diamond

Automotive components: Coating; Tools: Coating, Diamond films; Wear resistance: Coating effects

00-01 Nagakawa T.,Advances in prototype and low volume sheet forming and **tooling,J. of Mat. Proc. Technology**,2, V98,,244-250,2000

In the recent years, there are increasing demands for small lot production technologies to deal with diversifying needs and rapid forming tool production technologies to survive in gloval competition on the development of new products. The sheet metal forming technique requires the rapid production of toolings which are essential in the forming process. Many new rapid tooling methods are emerging. These methods standardize tooling parts, use materials which are easy to cut by high speed milling processes, build the toolings by the copy method, and apply rapid prototyping techniques. Also being developed are techniques which form the sheet metal with the single tool omitting either the punch or die.

Sheet metal forming; Prototyping; Rapid tooling

00-06 Faccoli, M,La Vecchia, G.M,Roberti, R.,Molinari, A.; Pellizzari, M.,Effect of different coatings on thermal fatigue behaviour of AISI H11 hot work tool steel,International **Journal of Materials and Product Technology** ,15,1,,49-62 ,2000

The improvement in wear and corrosion resistance induced by vapour-deposited coatings whether chemical (CVD) or physical (PVD) are well-known. In fact when the applied coating is thick enough it tends to be essentially pore free and dense providing an excellent barrier protection both in terms of corrosion and wear resistance. A typical application area for vapour-deposited coatings on ferrous alloys is the surface modification given by TiN or TiC PVD coatings to improve the service life of high speed steels used for manufacturing cutting tools. As a surface modification technique PVD is attractive because the different procedures proposed in the literature and industrially developed allow coatings to be obtained of controlled composition and strength thus making possible the extended use of coated tools for wider application fields such as the die-casting process in which die casting dies must withstand thermal shock, thermal fatigue and resistance to molten metals. In the present paper both nucleation and propagation of fatigue cracks induced by thermal fatigue cycling on AISI H11 hot work tool steel PVD coated with chromium nitride and titanium/aluminium nitride have been investigated. A further coating given by a dense film of magnetite (Fe3O4), employed as corrosion barrier and obtained by surface oxidation of the same AISI H11 hot work tool steel, has also been studied. The obtained thermal fatigue results have been compared with previous data from tests on the same uncoated steel and have been related to the morphology, chemical composition and physical proprieties of the tested coatings.

Protective coatings; Surfaces; Tool steel; Fatigue of materials; Crack propagation; Nucleation; Magnetite; Oxidation; Vapor deposition; Titanium nitride, Hot work tool steel; Thermal fatigue cycling; Physical vapor deposition; Surface oxidation

00-12 Moore J.J. ,Zhong, D. ,,,Synthesis, processing and properties of graded thin film/coating system,**Conference Surface Engineering in Materials Science I** (as held at the 2000 TMS Annual Meeting), Nashville, TN, USA, 12-16 Mar. 2000,,,Mar. 2000,101-113,2000

The concept of a graded coating system provides a high degree of versatility and potential with respect to engineering the required properties and performance in many coating and surface engineering applications. Each coating system should be designed to meet each specific application requirements and provide the best accommodation of chemical, physical, and mechanical properties desired to achieve high performance and reliability. This paper correlates synthesis, processing, and properties of graded coating systems through three specific examples: a graded Cr-N coating system that was developed for metal stamping dies, a MoSi2-SiC coating system developed for

oxidation protection of molybdenum, and a NiAl-TiAlN-TiN-Ti coating system developed for glass molding dies.

Dies: Coating; Chromium compounds: Coatings; Molybdenum: Coating; Molybdenum compounds: Coatings; Moldings: Coating; Titanium compounds: Coatings; Aluminum compounds: Coatings; Titanium: Coatings

00-20 Chen C.H.,Heat transfer characteristics of non-isothermal surface moving parallel to a free stream,**Acta mechanica**,142,,,195-205,2000

00-22 Yan W.,Busso E.P.,O'Dowd N.P.,,A micromechanism investigation of sliding wear in coated components,**Proc. Royal Society London A**,456,2387-2407,2000

In this work, the wear behaviour of coated components subjected to sliding contact conditions is investigated using a multiscale michromecanis approach. Periodic unit-cell-type continuum mechanics model are used to predict localized deformation pattern at the scale of the coating thickness (mesoscale) and the rate of material removal die to repeated sliding contact. To that purpose, realistic contact loads determined at the components level (macroscale) are applied at the mesoscopic level. The results indicate that the deformation of the coating is controlled by the cyclic accumulated of plastic deformation, or ratchetting, at the coating subsurface. Based on rachetting failure criterion, a wear equation is proposed and applied to investigate parametrically the influence of the principal material, loading and surface roughness parameters on the wear rate. The results reveal that the wear rate increases with contact pressure and depends on coating thickness and the roughness of the counterpart surface. It was also found that a reduction in the friction coefficient and an increase in the coating strain hardening behaviour can considerably improve the wear resistance of coated components.

sliding wear, micromechanics, wear-resistant coatings, ratchetting, wear rate

00-24 Samuel M.,Experimental and numerical prediction of springback and side wall curl in U-bendings of anisotropic sheet metals,**J. of Mat. Proc. Technology**,105,3,29 September 2000 ,382-393,2000

Springback is a common phenomenon in sheet metal forming, caused by the elastic redistribution of the internal stresses during unloading. It has been recognised that springback is essential for the design of tools used in sheet metal forming operations. A finite element (FE) program has been used to analyse the sheet metals axisymmetric U-bending process. The underlying formulation is based on Lagrangian elastoplastic materials model. Normal anisotropic material behaviour has been considered. A contact algorithm for arbitrarily shaped rigid tools has been realised by means of penalty approach. The interaction of sliding surfaces is modelled with a modified Coulomb friction law. This paper describes a robust method of predicting springback and side wall curls in 2D operations under plane strain stretching, bending and unbending deformations. Also the effect of tool geometry and blankholder force on the final shape after springback are discussed. The accuracy of the model is verified by comparison with FE of MARC package and experimental results.

Springback; U-bendings; Sheet metal

00-25 Zimniak Z.,Problems of multi-step forming sheet metal process **design,J. of Mat. Proc. Technology**,106,1-3, 31 October 2000,152-158,2000

This paper describes a numerical simulation of the deep-drawing process of the multi-operational forming of a compressor cover and its optimization by FEM simulation. Several modified tools were tested by simulation and optimized tool shapes from the point of view of minimum number of operations and optimum thickness changes of the

sheet at each stage of metal forming were found. The application of FEM into the metal forming processes is a powerful tool for more economical design and reducing costly trial-and-error processes.

Finite element simulation; Sheet metal forming; Industrial application

00-26 Shim H.,Suh Euikwon,,,Contact treatment algorithm for the trimmed NURBS surface**,J. of Mat. Proc. Technology**,104,3, 31 August 2000,200-206,2000

As a kind of surface description, the trimmed non-uniform rational B-spline (NURBS) surface is widely employed in CAD/CAM. The trimmed NURBS surface has many advantages in describing tool surfaces because of its simplicity in data preparation and the small amount of surface data compared to that of other surfaces. Despite its inherent advantages, the trimmed NURBS surface is rarely employed in the analysis of forming problems due to the complexity in the contact treatment. In this study, a contact treatment based on a sheet normal vector in the trimmed NURBS surface model is presented. For the sake of importing surface data, an initial graphics exchange specification (IGES) format input module has also been developed. The computed results for deep drawings of a clover shaped cup and an L-shaped cup are compared with experiments and the results of the commercial stamping analysis code PAM-STAMP.

Contact treatment; Trimmed NURBS surface; Deep drawing; IGES format; Sheet normal scheme

00-27 Lim T. C.,Ramakrishna S. ,,Shang H. M.,Simultaneous stretch forming and deep drawing in axisymmetrical sheet forming,**J. of Mat. Proc. Technology**,97,1-3, 1 January 2000, 82-87,2000

From the product point of view, the onset of a visible neck during sheet metal forming sets the limit to which a blank material can be formed. In any forming process, the blank material is subjected to deformations that are mixtures of typical stretch forming and typical deep drawing, interlaced in an intricated manner with the progression of forming. Through varying forming parameters such as blank size, tool profile and blank-holding force, this paper explores the complex relationship between the mixture and the overall formability of sheet metal.

Deep drawing; Stretch forming; Formability; Optimization

00-29 Chiu, L.-H,Yang, C.-F,Liu, P.-M,,Wear resistance of JIS SKD61 tool steels with Cr based coatings,**Surface Engineering** ,16,3,,257-261 ,2000

The wear behaviour of three chromium based metallic and compound coatings on a JIS SKD61 (AISI H13) tool steel has been investigated.Hard chromium, chromium nitride, and chromium carbide coatings were applied to the SKD61 steel using electroplating, cathodic arc plasma deposition, and thermoreactive diffusion respectively.Microstructures, crystal structures, and chemical compositions of the coated materials were examined using SEM, XRD, and GDOS.The microhardnesses of the hard chromium, chromium carbide, and chromium nitride coatings were found to be 943, 1667, and 2148 HV respectively.Results of wear tests showed that the hard chromium coating, with the highest friction coefficient and a low hardness value, exhibits the lowest wear resistance.The wear resistance of the chromium carbide and chromium nitride coated SKD61 steels was excellent: these coatings are very hard, with either strong cohesion bonding between the coating and the substrate or low friction coefficient

Steel; 804.2 Inorganic Components; 813.2 Coating Materials; 931.2 Physical Properties of Gases, Liquids and Solids; 933.1.1 Crystal Lattice; 813 Coatings and Finishes CT *Tool steel; Hardness; Wear resistance; Nitrides; Carbides; Crystal microstructure; Coated materials; Friction; Chromium compounds; Protective coatings, Tool steel JIS SKD61; Cathodic arc plasma deposition; Thermoreactibe diffusion

00-30 Jehn H.,Tribological PVD hard coatings,**Metalloberflache**,54,9,,64-67,2000

Development trends in multicomponent and multiphase hard coatings to improve friction and wear characteristics of tooling and dies are reviewed. Binary TiN-TiC and CrN-TiC coatings are well known and can be modified in terms of their morphology, texture, hardness, etc. Several studies of metals such as Zr, Hf, V, Nb, Ta, Cr, Mo, W, and Si with TiN and also CrN as base materials for "alloy" PVD coatings have resulted in higher hardness and multiphase structures. Other multicomponent systems such as Ti-Al-Si-N and W-Ti-C,N result in multiphase structures. Amorphous structures are also produced as in the W-Si-N system. Comparative wear characteristics of various types of PVD coatings show the advantages of combining MoS2 with TiN. Quasi-binary TiN-TiB2 coatings made by Ion Beam Assisted Deposition with up to 10at% B are available. Multilayered CVD/PVD coatings such as Ti/TiN and Cr/CrN may offer tribological advantages. The hardness and structure of multilayer TiN/VN and TiN/NbN coatings are presented. Nanocomposite coatings, characterized by two or more phases with hard/hard, hard/soft and hard/lubricant layers, are also discussed.

Tooling: Coating; Dies: Coating; Titanium nitride: Coatings; Titanium carbide: Coatings; Chromium compounds: Coatings; Protective coatings: Mechanical properties; Wear resistance: Coating effects; Frictional wear: Coating effects

00-31 Driessen, J.P.A.M,Kuypers, A.D,Schoonman, J.,,Gas-phase chemistry in up-scaled plasma enhanced metal-organic chemical - vapor deposition of TiN and Ti(C, N) on tool steel**.,Journal of Vacuum Science and Technology, Part A: Vacuum, Surfaces and Films** ,18,4,July,1971-1976 ,2000

The tetrakis(diethylamine)titanium (TDEAT) decomposition was experimentally analyzed by mass spectroscopy and the results were compared to the previous studies.A quantitative analysis of gas-phase species enabled to determine that, although TDEAT contains more carbon, its decomposition in a N2 plasma results in a lower carbon content in its solid products than if TDMAT is used. With this, TDEAT results in purer TiN coatings

Protecting Materials; 813.2 Coating Materials; 804.2 Inorganic Components; 545.3 Steel; 802.2 Chemical Reactions; 932.3 Plasma Physics, Protective coatings; Titanium nitride; Titanium carbide; Metallorganic chemical vapor deposition; Plasma enhanced chemical vapor deposition; Tool steel, Titanium carbonitride

01-24 Cao J.,Li S. ,Xia Z.C., Tang S.C.,Analysis of an axisymmetric deep-drawn part forming using reduced forming steps,**J. of Mat. Proc. Technology**,117,,November,193-200,2001

Numerical simulation have been widely used to assist part and process desing. In this paper, deep-drawing processes of an axisymmetric part with a complex geometry are analyzed with the aim of reducing possible forming step. The existing practice requires a 10-step drawing. Our approach combines a optimization scheme, design rules and numerical test using the finite-element analysis incorporated with a damage model. As a result, the 10-step drawing is reduced to 6-step drawing. Additionally, the new process design yields a lower maximum void volume fraction in the sheet, meaning a more formable process and a slihtly higher press load.

01-25 Wan Min,Yang Yu-Ying, Li Shuo-Ben,,Determination of fracture criteria during the deep drawing of conical cups,**J. of Mat. Proc. Technology**,114,2, 20 July 2001,109-113,2001

In consideration of the effects of factors such as the tool geometry, material anisotropy and workingłhardening, the fracture criteria, which are expressed by the equations of limit stress and limit load during conical cup drawing, are formulated theoretically based on the stressłstrain states on the critical section of fracture using Swift's instability criterion, and they are proven experimentally to be accurate. Therefore, they can be used for judging whether the process can form successfully and for determining the limit deformation of conical cups.

Deep drawing; Limit stress; Limit load; Tensile instability; Conical cups

01-30 Doege E.,Dr der K. ,,,Sheet metal forming of magnesium wrought alloys ¿¿ formability and process technology,**J. of Mat. Proc. Technology**,115,1,August,14-19,2001

New developments at the Institute for Metal Forming and Metal Forming Machine Tools show that magnesium sheets possess excellent forming behavior, if the process is conducted at elevated temperatures. For the evaluation of mechanical properties relevant for forming of magnesium sheets, uniaxial tensile tests have been carried out at various temperatures and strain rates. Deep drawing tests with magnesium alloys AZ31B, AZ61B, and M1 show very good formability in a temperature range between 200 and 250¡C. Besides temperature, the influence of forming speed on limit drawing ratio has been investigated. The obtained results lead to the conclusion that it is possible to substitute conventional aluminum and steel sheets by using magnesium sheet metal wrought alloys.

Magnesium alloys; Sheet metal forming; Tensile test; Elevated temperature

01-31 Moon Y. H. ,Kang Y. K. ,Park J. W. ,Gong S. R. ,Tool temperature control to increase the deep drawability of aluminum 1050 sheet,**Int. J. of Mach. Tools and Manufacturing**,41,9,July 2001 ,1283-1294,2001

A feasibility study on the tool temperature control to increase the deep drawability of Al-1050 sheet is performed. The conventional deep drawing process is limited to a certain limit drawing ratio (LDR) beyond which failure will ensue. The purpose of this study is to examine the possibilities of relaxing the above limitation through the tool temperature control, aiming towards a process with an increased LDR. The idea which may lead to this goal is strengthening the punch-nose radius part by cold punch which has frequently been potential failure area in cup drawing process, while heating the remainder of the blank to reduce the stress on the cup sidewalls. Over the ranges of conditions investigated, the deep drawability of Al-1050 is found to be strongly sensitive to the temperature of the die and punch. The experimental implementation shows that the tool temperature control is very effective way to promote deep drawability of Al-1050.

Limit drawing ratio (LDR); Deep drawing; Tool temperature control; Al-1050