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Retraction

Retracted: Study of Surface Roughness of Cutting Isothermally Hardened Ductile Iron in Tosa Knife Forging Technique Based on Intelligent Calculation

Mathematical Problems in Engineering

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Zhang, "Study of Surface Roughness of Cutting Isothermally Hardened Ductile Iron in Tosa Knife Forging Technique Based on Intelligent Calculation," *Mathematical Problems in Engineering*, vol. 2022, Article ID 9573713, 10 pages, 2022.

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Research Article

Study of Surface Roughness of Cutting Isothermally Hardened Ductile Iron in Tosa Knife Forging Technique Based on Intelligent Calculation

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With a long history of more than 600 years of development, the Achang Tosa knives have always been handmade and made in strict accordance with tradition and absorbing the essence of foreign cultures. It is not only a tool or a gift, but also a "knife culture" and a local "folk culture" with local ethnic characteristics in Yunnan. In this paper, we begin our research on the Achang Tosa knives by compiling literature and conducting field research to investigate the "knife culture" jointly created by the Achang and neighboring ethnic groups by studying the forging process of the Achang Tosa knives. Three sets of specimens were prepared and the mechanical properties were determined by combining the existing isothermal quenched ductile iron (ADI) material production, and a high-speed cutting test was carried out with a CC650 ceramic tool to investigate the relationship between the machined material, tool material, and cutting dosage-surface roughness during high-speed cutting of ADI; based on the particle swarm algorithm, a theoretical model between surface roughness and cutting parameters was established to provide theoretical guidance for the optimal production process of ADI in high-speed cutting. It provides more valuable experience for the protection of intangible cultural heritage of ethnic minorities and also provides reference for the development and protection of unique crafts of other ethnic minorities.

1. Introduction

The Tosa knife, also known as the Achang knife, is called "Mengshuo cap" in Achang language and is named after the Tosa and Lasa areas in Longchuan County, Dehong Dai and Jingpo Autonomous Prefecture, where the Achang people live [1]. According to folklore, historical records, and archaeological objects, the Achang knife is the oldest surviving combat knife in China [2]. With its unique forging technology and rich cultural connotation, it reflects the integration and unity among the hardworking and simple Achang people and various ethnic groups and shows the living customs, national history, and wisdom crystallization of the Achang people [3].

Since the founding of New China, individuals and various organizations have never stopped researching the history of the Achang people and their knife craftsmanship [4]. As early as in the 1970s [5], a professor did an in-depth investigation on this topic and published a paper on "The iron making of the Achang," which was published in "History and Culture of Southwest China" in 1987, and then a program produced by CCTV showed the Tosa knife and its making process for the first time in front of people all over the country, which received wide attention from the academic and social circles. More and more scholars have studied it in detail, and the Achang Tosa knife has been more and more familiar and loved by more and more people, coming into people's lives [6]. The Five Series of Ethnic Issues published by the Yunnan Provincial Editorial Committee and Yunnan Ethnic Publishing House and the Achang Iron Making Technology and Related Issues by [7, 8] also contain studies on the Achang and their knife crafts, such as the wrong copper technology, quenching technology, carburization technology, and decoration technology.

In addition, foreign studies have been done to some extent on the Achang and their knife craftsmanship, but most of these studies were conducted on the history of the late Qing Dynasty and the World War I and II period when the British and French were stationed in Burma, and there are very few studies specifically on the Achang, and it is difficult to guarantee the quality of these studies because of the language barrier [9, 10]. This study starts from the technological craft of Tosa knife, mainly using documentary research method, ephemeral and cotemporal research methods, field survey method, and application of comprehensive analysis to analyze the value of the craft, to understand the historical changes of ethnic minorities, to find out many urgent problems behind the craft, and to focus on the bloodline between ethnic groups, especially how, in the social environment of extremely flooded cultural industrialization, traditional handicrafts of ethnic minorities are more in need of inheritance and protection by today's society [11, 12].

Austempered Ductile Iron (hereinafter referred to as ADI) is isothermally quenched at different temperatures to achieve high strength, high toughness, high fatigue, and wear resistance in the field of mechanical engineering; it is regarded as a high-tech material [13] and has been widely and successfully used in aerospace, vehicles, ships, and heavy industries internationally. However, due to the similarity of its processing properties and forged steel, the lack of a unified national standard, and the large differences in the material of ADI materials produced by various manufacturers, in the use of traditional processing methods and tools to process ADI, the tool wear is serious, which is a more difficult material to machine, often using time-consuming and labor-intensive annealing and grinding processes [14, 15].

Ceramic tools are internationally recognized as the most promising high-speed cutting tools, and their hardness is second only to diamond and polycrystalline cubic boron nitride tools, which significantly improve the machining efficiency, machining accuracy, and surface quality of parts and contribute to the realization of green manufacturing [16–19].

Surface roughness is an important indicator of the performance of the cutting process. At present, the change law of surface roughness in high-speed cutting is still in the research stage, and its formation mechanism is not perfect [20, 21]. With the improvement of workpiece quality requirements and the popular application of automated machining, the forecast of surface roughness will become an important research direction for the quality analysis of metal cutting [22, 23].

Three different sets of specimens were prepared and CC650 ceramic tools were used to perform high-speed cutting tests to investigate the relationship between machining material, tool material, cutting dosage, and surface roughness during high-speed cutting of ADI; the theoretical model between surface roughness and cutting parameters during high-speed cutting of ADI was established based on particle swarm algorithm to analyze the influence law and provide useful theoretical guidance for the optimal production process of high-speed cutting of ADI [24, 25].

2. Achang Tosa Knife Forging

Yunnan has a long history of using iron as a rich cultural resource. The Achang Tosa knife is the most famous of them all. The production process of the Achang Tosa knife is tedious, but the skills of the knife maker are very important. Among them, material selection and quenching skills are especially important. If the material selection is not suitable, no quenching can make a qualified Tosa knife, and if the quenching is not appropriate, even the best material will be wasted.

2.1. Material Selection and Refining. Before the Second World War, due to the scarcity of steel, woolen iron was the main material for making Tosa knives; after the Second World War, discarded old steel or new steel billets were the main material; nowadays, the raw material for making Tosa knives is mainly spring steel of Dongfeng car or discarded railroad rails; generally, one kilogram of iron can be bought for more than one yuan. The selected raw materials will be heated at high temperature in the furnace, while using a bellows or blower to increase the heat. Hardness is the resistance of the material to harder objects pressed into it, is a measure of the hardness and softness of the material, hardness can directly affect the material wear resistance index) can be completed practice material.

2.2. Forging and Repairing. The fired raw materials will be clamped out, and the master and apprentice will work together on the treadle to complete the beating. The master makes a small hammer, the apprentice with a sledgehammer overfires it, with forging, repeatedly until the steel is cold and hard, and then the steel will be red, and forging will be continued, so that it needs to repeat the link many times or even dozens of times, until the beaten shape is satisfactory. And this satisfactory standard refers to the idea that the knife leaf toughness is up to standard, toughness of the term generally corresponds to brittleness, with toughness of the knife being not easy to break, not easy to open, and tough, with fatigue resistance. The seven-colored knife of Achang Tosa knife is made of seven layers of steel; after 18,600 times of forging, the traces of forging can be seen in the blade. After repeated forging, the master uses small hammers and other tools to refine the overall shape of the blade and make final adjustments to the shape.

2.3. Leaf Decoration and Hardening. Generally, ethnic craft knives spend a lot of effort in this step to improve their ornamental value. Agricultural tools are generally not decorated with leaves, decorative leaves are first polishing treatment of the knife leaves, and master craftsmen in accordance with the requirements of the knife on the knife leaves use special tools to complete the pattern outline, cutting surface groove, and burin (mostly used in flowers and plants and other patterns of carving), in the pattern of gold and silver or copper, inlaying nonferrous metals and other steps. Quenching is also known as "dipping fire"; "dipping fire" is the industry term for quenching process, which originated in the process of processing methods, but also the most important part of the Tosa knife making process. Quenching is the process of dipping a hot workpiece heated to a certain degree into a medium, which is completed after repeated operations. The knife is cooled to a certain temperature, and then the knife body or all of it is repeatedly polished to improve the hardness of the prop. This process is different from other processing (welding, cutting process, etc.); in general, it is mainly by changing the organization of steel to achieve the purpose of improving performance, without changing its shape and size. Steel in quenching commonly uses cooling media as oil, water, brine, mineral oil, etc. Cooling in oil is slower, cooling in water is faster, and cooling in brine is faster, according to different requirements to choose the cooling medium. Tosa knives have been developed for more than 600 years and have a reputation of being “soft as a finger, sharpening iron like mud.” When measuring whether a knife maker has excellent skills, the level of quenching skills is an important indicator. In the background of mechanical production, as Tosa knives became more and more famous, more and more foreign craftsmen and young artisans were eager to make quick profits, which led to the lack of mastery of quenching skills, and the quality of knives was greatly compromised.

2.4. Shank Making, Sheath Making, Belt Making, and Assembly. After completing the above process, the production of knife accessories is also very delicate. Based on the shape of the blade and the weight of the blade, the sheath and the handle are made, which requires not only the master knife maker to judge the material of the handle according to the blade, but also the imagination and aesthetic vision to choose the matching sheath. The material of the hilt and sheath of Tosa knife is very careful; the hilt and sheath are generally divided into wood and metal materials, with the process of wrapping brown silk, inlaid with copper ring, pinch silk enamel, and so on. Wooden material includes brown silk (wrapped), chicken wing wood, sourwood, Indian mahogany, small leaf rosewood, cow horn, antler, etc. Metal materials include rigid texture, copper texture, and Burmese silver texture, etc. Knife sheaths are divided into wooden sheaths, half-shell sheaths, silver sheaths, leather sheaths, etc., with a wide range of styles, exquisite selection of materials, and unique craftsmanship. The belt making refers to the process of fixing the knife handle and sheath with the materials taken locally, and the materials used are several kinds of woven belts of bamboo scrimshaw and cotton thread. After the above process, the forging process of Tosa knife is completed.

3. Experimental Research Method

3.1. Workpiece Material Preparation. The test materials were prepared at Qishuyan Rolling Stock Technology Research Institute of CSR Group: ductile iron made of 60 mm diameter, 400 mm long cylindrical specimen, first by 890°C insulation 2 h to austenite, and then in the nitric acid tank at 300°C, 350°C, and 400°C isothermal 1 h after air cooling. The chemical composition of the specimens before heat treatment is shown in Table 1, and the mechanical properties of ADI materials are shown in Table 2.

3.2. Machine Parameters. They include CYNC-400P general CNC lathe, main motor power 4 KW, maximum bed rotation diameter 400 mm, maximum workpiece length 1000 mm, and maximum spindle speed 2500r/min.

3.3. Tools. The inserts for the ceramic tools (Al_2O_3/TiC) were produced by the famous Swedish company Sandvik, with the model number SNGA120408T01020 SNGA432T- 0320 CC650, and their dimensions were 12 mm × 12 mm × 4.8 mm. All insert geometries are the same: $\gamma_o = -6^\circ$, $\alpha_o = 6^\circ$, $\lambda_s = -4^\circ$, $K_r = 75^\circ$, $K_r' = 15^\circ$, $r_\varepsilon = 0.8$ mm, $b_{r1} = 0.1$ mm, $\gamma_{01} = -26^\circ$.

3.4. Test Content. According to the specific test conditions to arrange the cutting process, the surface roughness of the workpiece was measured by T1000A portable roughness measuring instrument (Harbin Gauge and Cutting Tools Group Co., Ltd.). Based on the particle swarm algorithm, the theoretical model between the surface roughness and cutting parameters was established during the high-speed cutting of ADI, and the influence law was analyzed. The cutting method is dry cutting.

4. Cutting Parameters on the Impact of Surface Roughness

The surface roughness achieved by dry cutting ADI material is the key factor to achieve the process of “turning instead of grinding”; at the same time, it is also an important indicator to evaluate the quality of the machined surface in the cutting process; the study of surface roughness has a direct impact on the cutting performance of the analyzed material. Considering that the surface quality of the workpiece is affected by the cutting dosage (i.e., cutting speed, feed rate, depth of cut), workpiece performance, tool parameters, etc., the CC650 tool was used to establish the high and low level values of cutting speed, feed rate, and depth of cut for three ADI specimens under the same conditions, and the average value of the two was taken as the middle level. The surface roughness was then measured with a surface roughness measuring instrument, and based on this, the roughness values obtained were compared. Finally, according to the displayed results, it is possible to know how to choose the cutting dosage to obtain the minimum surface roughness when making such cuts. The specific experimental data are shown in Tables 3–5.

As can be seen from Table 3, the workpiece surface roughness values of group 3 and group 7 are the smallest. At this time, the cutting speed of both groups is high level, the feed is low level, while the depth of cut of the former is at high level and the depth of cut of the latter is at low level. Group 3: $v = 280$ m/min (high level), $f = 0.08$ mm/r (low level), and $a_p = 0.2$ mm (high level). Group 7: $v = 280$ m/min (high level), $f = 0.08$ mm/r (low level), and $a_p = 0.1$ mm (low level). Then

Table 1: Chemical composition of the specimens before heat treatment (%).

C	Si	Mn	P	S	Mg	Re	A1	Ti
3.1–3.9	2.0–3.0	≤0.4	≤0.10	≤0.03	≥0.02	≥0.02	≤0.05	≤0.004

Table 2: Mechanical properties of ADI materials.

Group no.	Isothermal temperature ($^\circ C$)	Tensile strength (Pa)	Elongation (%)	Fracture condition	Hardness
ADI1	300	1385	1.80	Normal	45.8HRC
ADI2	350	1390	2.80	Normal	41.5HRC
ADI3	400	1080	1.55	Normal	37.8HRC

Table 3: CC650 cutting ADI1 experimental data table.

Group no.	v (m/min)	f (mm/r)	a_p (mm)	R_a (μm)
1	285	0.25	0.25	1.86
2	155	0.25	0.25	1.89
3	285	0.09	0.25	0.77
4	155	0.09	0.25	0.96
5	285	0.25	0.12	1.79
6	155	0.25	0.12	1.93
7	285	0.09	0.12	0.77
8	155	0.09	0.12	0.90
9	220	0.15	0.16	1.16

Table 4: CC650 cutting ADI2 experimental data sheet.

Group no.	v (m/min)	f (mm/r)	a_p (mm)	R_a (μm)
1	285	0.25	0.25	1.72
2	155	0.25	0.25	1.73
3	285	0.09	0.25	0.46
4	155	0.09	0.25	1.64
5	285	0.25	0.12	1.62
6	155	0.25	0.12	1.46
7	285	0.09	0.12	0.52
8	155	0.09	0.12	0.61
9	220	0.15	0.16	0.99

comparing these two groups with groups 1 and 5, it will be found that the cutting speed and feeds have a relatively large effect on the surface roughness of the workpiece, while the effect of depth of cut is relatively small.

Table 4 shows that the workpiece surface roughness value of group 3 is the smallest; at this time, its cutting speed is high level, feed is low level, and depth of cut is high level. That is, $v = 280$ m/min (high level), $f = 0.08$ mm/r (low level), and $a_p = 0.2$ mm (high level). Comparing this group with group 1, group 4, and group 7, it is also found that the effect of cutting speed and feed on the surface roughness of the workpiece is relatively large, while the effect of depth of cut is relatively small.

In Table 5, the surface roughness of the workpiece is also the smallest in group 3, which is 0.46 μm. The levels of cutting parameters are the same as those in Table 5, and the order of influence of each parameter on the surface roughness of the workpiece is also similar. Figure 1 shows the 200x micrograph of the workpiece surface corresponding to group 3 in Table 4.

Table 5: CC650 cutting ADI3 experimental data sheet.

Group no.	v (m/min)	f (mm/r)	a_p (mm)	R_a (μm)
1	285	0.25	0.25	2.05
2	155	0.25	0.25	2.07
3	285	0.09	0.25	0.45
4	155	0.09	0.25	0.58
5	285	0.25	0.12	1.57
6	155	0.25	0.12	1.69
7	285	0.09	0.12	0.56
8	155	0.09	0.12	0.52
9	220	0.15	0.16	0.96

Figure 1: Machining workpiece surface (200x). $v = 280$ m/min, $f = 0.08$ mm/r, and $a_p = 0.2$ mm.

The results obtained from the above three sets of experiments are very normal. From the formula for calculating surface roughness

$$R_{\max} = \frac{f^2}{8\gamma_\varepsilon}. \quad (1)$$

It can be seen that the maximum residual height of the machined workpiece surface is mainly determined by the feed in the case of a consistent blunt radius of the tool. The test proves that the dry cutting ADI can also obtain a small surface roughness. Most of the workpiece surface roughness values in the experimental group cutting dosage are below 1.6μm, and the lowest is even 0.45μm, which reaches the level of grinding. This is due to the high hardness and toughness of the ADI material, and the plastic deformation during machining, the extrusion between the tool and the machined surface to a certain extent to improve the surface quality. At the same time, the self-lubricating property of CC650 ceramic tools is better, and the friction coefficient between the workpieces is smaller, so the friction between the tool and the workpiece during the turning process is smaller, and it is not easy to form a stagnant layer and chip tumor on the front tool surface; therefore, a better surface quality can be obtained. This also proves that the ceramic tool cutting isothermal quenching ductile iron can be achieved by "turning instead of grinding."

5. Particle Swarm Algorithm for Cutting Surface Roughness Prediction Model

The Particle Swarm Optimization algorithm was developed by James Kennedy and Russell Eberhart from a study of bird population behavior, using biologist Frank Heppner's biological population model. The algorithm discovers the optimal region in the complex search space through the interaction between particles, which has the advantages of simplicity, easy implementation, powerful function, convergence, and generality. The application of the particle swarm algorithm to the identification of the parameters of the cutting surface roughness prediction model is of great practical importance to achieve preprocessing prediction and then optimize the control of the cutting surface quality and improve the cutting efficiency.

5.1. Establishment of Mathematical Model

(1) Experimental scheme: Through the analysis of the relationship between cutting parameters on surface roughness, and combined with the actual cutting conditions, the experimental design variables were determined as cutting speed v_c , feed f, and back draft a_p , and the measured uncontrolled quantity was surface roughness R_a. The mathematical and theoretical model of surface roughness prediction was established as shown in the following equation:

$$R_a = k v_c^x f^y a_p^z = e^{x_1} v_c^{x_2} f^{x_3} a_p^{x_4}. \tag{2}$$

(2) Objective function: According to the mathematical theory model formula of surface roughness prediction shown in equation (2), the objective function of equation (3) can be established as follows:

$$\min\left(x_1, x_2, x_3, x_4\right) = \sum_{i=1}^{9} \left| e^{x_1} v_{ci}^{x_2} f_i^{x_3} a_{pi}^{x_4} - R_{ai} \right|, \tag{3}$$

where the constraint, i.e., the solution space, is expressed as shown in

$$X_{\min} \le X_i \le X_{\max}, \tag{4}$$

where $X_{\min}, X_{\max}$ are the upper and lower limits of the variable values, respectively.

(3) Description of the particle swarm algorithm of the prediction model: Let $X_i = (x_{i1}, x_{i2}, x_{i3}, x_{i4})$ be the current position of particle *i*; $V_i = (v_{i1}, v_{i2}, v_{i3}, v_{i4})$ be the current flight speed of particle *i*; $P_i = (p_{i1}, p_{i2}, p_{i3}, p_{i4})$ be the best position experienced by particle *i*, i.e., the position experienced by particle *i* with the best target value. The best position at this point is the individual best position, or the local optimum. The local best position is updated as shown in the following equation:

$$P_i(t+1) = \begin{array}{l} P_i(t) \\ X_i(t+1). \end{array} \tag{5}$$

Let the best position through which all particles in the population pass be $P_g(t)$, and its updated expression is shown in (6) below.

$$P_g(t) = \min\left\{ f\left(P_0(t)\right), f\left(P_1(t)\right) \ldots f\left(P_n(t)\right) \right\}, \tag{6}$$

where $f(\cdot)$ is the objective function. The speed evolution equation can be described as shown in (7), where the first part of the evolution equation is the previous speed of the particle, the second part is the "cognitive" part, i.e., the particle's own experience and its own learning, and the third part is the "social" part, i.e., the social information sharing among the particles.

$$\begin{aligned} V_{ij}(t+1) = v_{ij}(t) &+ r_1 r_{1j}(t)\left[p_{ij}(t) - x_{ij}(t)\right] \\ &+ r_2 r_{2j}(t)\left[p_{ij}(t) - x_{ij}(t)\right]. \end{aligned} \tag{7}$$

Its position evolution equation can be described as shown in

$$x_{ij}(t+1) = x_{ij}(t) + v_{ij}(t+1). \tag{8}$$

The particle swarm algorithm of the prediction model can be described as follows:

Step 1. Initialize the initial position and initial velocity of the particles.

Step 2. Calculate the adaptation value of each particle according to equation (3).

Step 3. For each particle, perform local update according to equation (5).

Step 4. Update globally for each particle according to equation (6).

Step 5. Evolve and update the velocity and position of the particles according to evolution equations (7) and evolution equation (8).

Step 6. If the end condition is not satisfied, return to the second step of the cycle.

5.2. Computer Simulation Experiments

(1) Simulation experiments: The computer simulation program is built according to the description of the particle swarm algorithm of the prediction model. The number of particle swarm is set to 30 and the

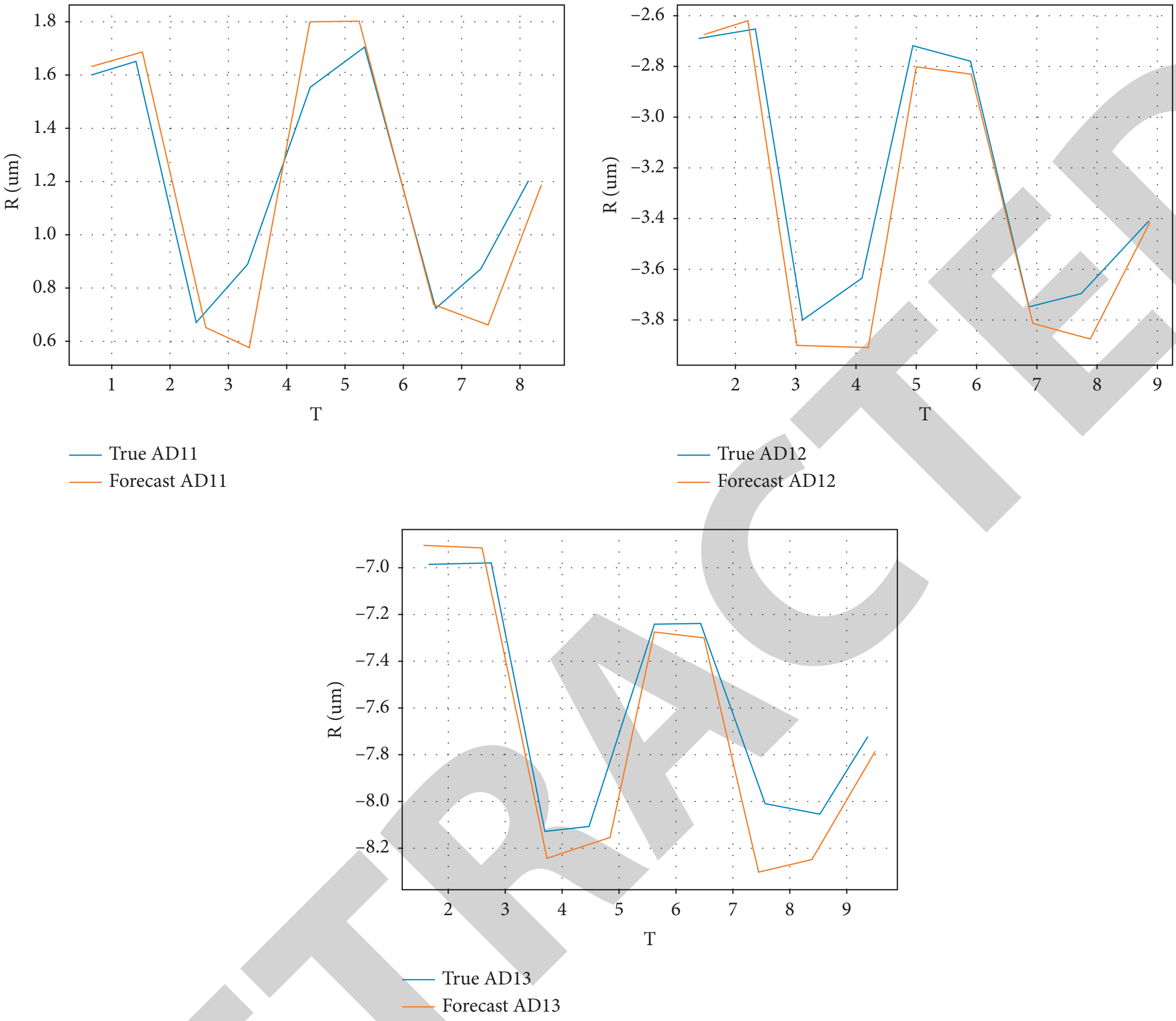


Figure 2: Comparison of measured and predicted values of ADI surface roughness.

number of iterations is 500, and the experimental results are shown in equations (9)–(11). The comparison between the measured surface roughness and the predicted value of the simulation experiment is shown in Figure 2.

$$R_a = e^{2.195764} v^{0.027044} f^{1.049691} a_p^{0.000003}, \tag{9}$$

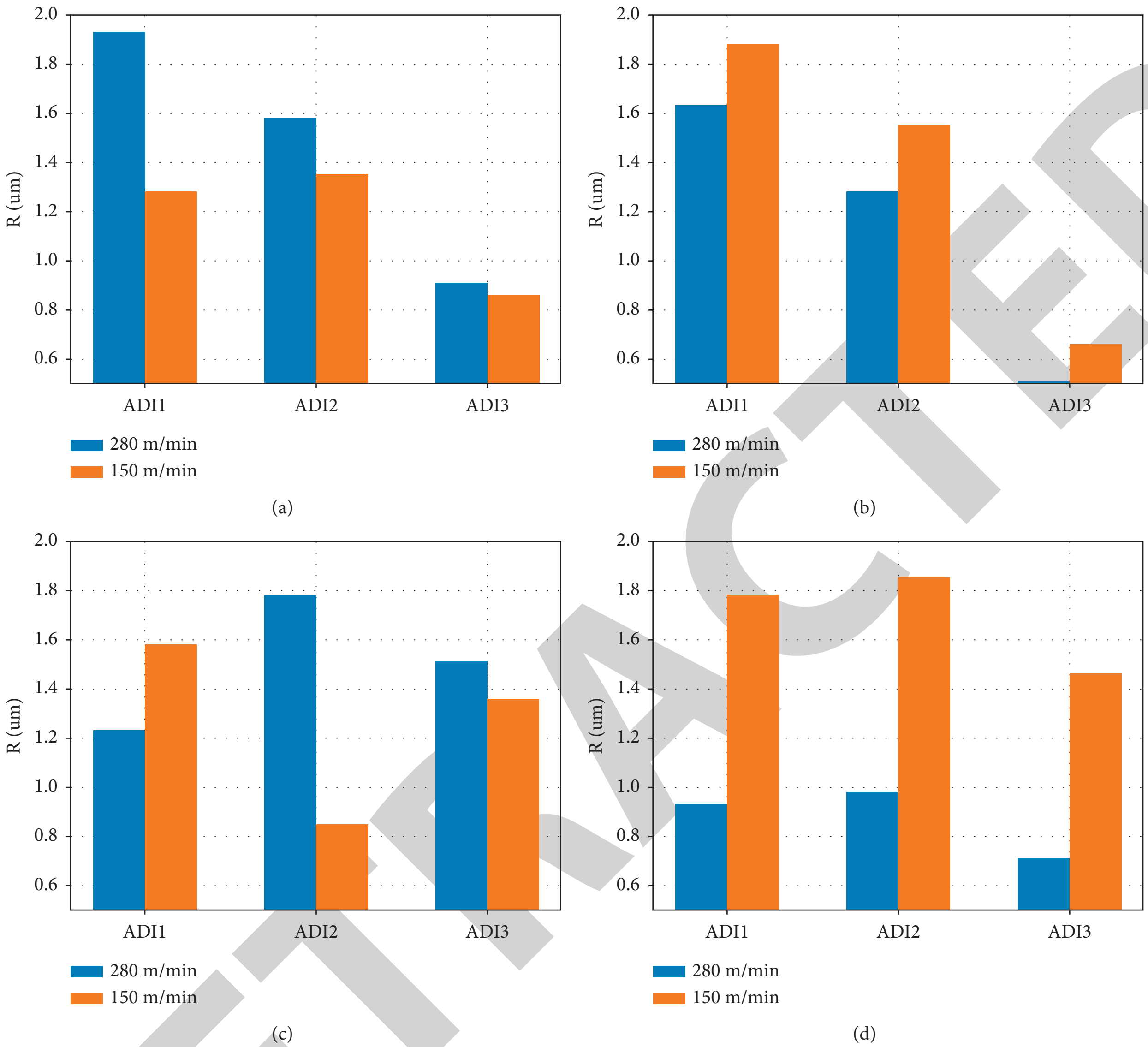
$$R_a = e^{2.806886} v^{0.024307} f^{1.418497} a_p^{0.082919}, \tag{10}$$

$$R_a = e^{3.859964} v^{0.006420} f^{1.633840} a_p^{0.339267}. \tag{11}$$

(2) From Figure 2, we can see that the particle swarm algorithm applied to the identification of roughness model parameters can meet the expected requirements; the average prediction error of each group is basically about 10%. However, in actual production, the prediction accuracy may be affected due to factors such as shrinkage in ADI material, hard particles, or accuracy of measurement data, especially in this experiment, which is still the primary of particle swarm algorithm.

(3) The effect of workpiece material on surface roughness: The workpiece material has a significant effect on the surface roughness of high-speed hard turning. According to the above three sets of experiments, the roughness values obtained from cutting ADI three specimens under different cutting parameters are compared, and the influence of workpiece material properties on the surface roughness can be seen more clearly (see Figure 3).

The test results show that the workpiece material properties play a significant role in the machined surface roughness during high-speed hard turning, which determines the selection of reasonable cutting dosage.



(a) (b) (c) (d)

Figure 3: The influence of workpiece material properties on surface roughness. (a) $f = 0.2$ mm/r, $a_p = 0.1$ mm. (b) $f = 0.2$ mm/r, $a_p = 0.2$ mm. (c) $f = 0.08$ mm/r, $a_p = 0.2$ mm. (d) $f = 0.08$ mm/r, $a_p = 0.1$ mm.

6. Cutting Process on the Impact of Surface Roughness

In the cutting process, the actual process system is a very complex vibration system; the ideal state without processing vibration and environmental impact does not exist. The vibration in the system causes a slight change in the relative position between the workpiece and the tool, which eventually increases the surface roughness of the workpiece and reduces the surface quality. Scholars found that machine tool spindle vibration, guide vibration, and tool vibration have high frequency, small amplitude characteristics, chip tumor, external interference, machine tool rigidity, and high-speed rotating parts; unbalance will also cause cutting vibration, resulting in changes in the microscopic characteristics of the machined surface.

In the CC650 cutting ADI2, when cutting with cutting parameters $v = 280$ m/min, $f = 0.08$ mm/r, and $a_p = 0.2$ mm, the machining process experienced severe vibration with harsh noise, and the machined surface roughness was $R_a = 1.25$ μm. The surface roughness was reduced to 0.45 under the same cutting conditions after taking vibration elimination measures. In addition, the presence of vibration aggravates the breakage and failure of the ceramic tool, which also has a negative impact on the machined surface quality.

7. Conclusion

(1) There is an optimal cutting dosage when cutting ADI with CC650, and the appropriate cutting dosage can be selected to reduce tool wear, improve labor productivity, and reduce cost, which further proves that the ceramic tool cutting isothermal quenched ductile iron can be achieved by "turning instead of grinding."

(2) In the test, it is found that the closer the tool is to the lathe fixture, the better the surface quality of the workpiece is obtained. Due to the heavy workpiece, the surface quality was affected by the presence of small vibrations even though the root of the workpiece was supported by the tailstock.

(3) The theoretical model between the surface roughness of the workpiece and the cutting parameters in the dry high-speed cutting of three ADI processes with CC650 ceramic tools was established based on the particle swarm algorithm with

$$\begin{aligned} ADI1\colon R_a &= e^{2.195764} v^{0.027044} f^{1.049691} a_p^{0.000003}, \\ ADI2\colon R_a &= e^{2.806886} v^{0.024307} f^{1.418497} a_p^{0.082919}, \\ ADI3\colon R_a &= e^{3.859964} v^{0.006420} f^{1.633840} a_p^{0.339267}. \end{aligned} \tag{12}$$

The microparticle swarm algorithm is able to identify the parameters of the surface roughness prediction model, and further research is needed to improve the algorithm and combine it with neural networks to identify the parameters of surface roughness, cutting temperature, cutting force, and other prediction models.

8. Discussion

The Achang Tosa knife forging process embodies the strong ethnic culture of Yunnan's various ethnic groups. Its unique forging process and rich cultural connotation reflect the integration and unity of the hardworking and simple Achang people and various ethnic groups. During the field research, we learned that the completion of a "Tosa knife" requires the participation of multiple ethnic groups from material selection to production to carving. It has played an indelible role in the unity of ethnic minority regions in the border areas. For more than 600 years, the Achang, Jingpo, Lisu, and other minority peoples have worked together through thick and thin to create a chapter of which we can be proud. The traditional forging process has been tested and verified over the years and will eventually play a significant role in people's lives, meeting their needs and having a certain collection value. The fact that people buy Tosa knives to achieve the effect of calming down the house and warding off evil spirits shows that Tosa knives are no longer mere production and living tools but have a spiritual dimension. The forging process has undergone a long history of evolution and renewal of forging skills, further reflecting the improvement of social productivity level. The process of making the knife, from the primitive manufacturing of traditional techniques to the improvement of modernization, is the process of creating life for the people of Yunnan minority areas. However, with the rapid development of productivity, the production of Tosa knife has also produced the phenomenon of modern commodity reproduction for quick success and profit, coupled with the national social security needs, which to a certain extent limits the inheritance and development of Tosa knife, and its characteristic national traditional craft is also dying out at an untold speed. During the research process, it was found that many departments and folk craftsmen did not deeply understand the national significance of the Tosa knife for the Achang people but only talked about the Tosa knife and how much wealth and income it had created and failed to think about where the "tomorrow" of the Tosa knife with its huge benefits was from the aspect of national cultural preservation.

From the perspective of economic development and legal policies, the flexible and rational formulation of legal policies directly leads to significant economic improvement. From the policy and economic support of Tosa knife production and processing, that is, to support the economic development of more than 20,000 people, it is understood that, through the support, the Tosa knife industry in the quality, production, and price of the knife has a large step forward, from the original several yuan a hand, to now several thousand dollars a hand, or even to tens of thousands of dollars a hand. At the same time, the shoddy props are rampant in the market, bringing serious obstacles to the long-term development of Tosa knives. There is an urgent need to change the production mode, business philosophy, and sales method while preserving the traditional forging process and invest in the research and development of new products to meet people's needs for quality of life and art appreciation, so that the Achang Tosa knife is not only a kind of knife or minority gift knife, but also the "Tosa knife culture" with local ethnic characteristics of Yunnan after transformation. It is not only a kind of knives or minority gift knives, but also the "Tosa knife culture" and "Achang culture" of Yunnan.

From the perspective of inheritance value and national culture protection, both the national cultures of the world and the five thousand years of Chinese civilization are deeply penetrated in the whole process of the emergence, rise, and fall and development of the nation, and it is the main expression carrier of national culture inheritance. The Tosa knife has a history of more than 600 years, and when it comes to the development of ethnic minorities, the first and foremost issue that should be addressed is inheritance. Without inheritance, how can there be development? Without good protection of minority cultures, how can we talk about development if we cannot protect them in the face of the subtle influence and changes of modern social life on the way of life of minority areas? This urgently requires the participation of the government, society, and its members. Efforts are being made to preserve the culture and achievements of ethnic minorities. The traditional Tosa knife craft takes at least four years to be passed down, but the penetration of popular culture is changing the perceptions of young people, with the number of local youths working outside the home increasing year by year and the Tosa knife business being replaced by foreigners. Over the past hundred years, the Tosa knife has also gone through several ups and downs, just like the fate of people. Today, in the face of modernization, the increasingly developed mechanization, and the replacement of manual production by batch production, the exquisite skills of Achang Tosa knife are in danger of being lost and need to be rescued and protected.

The crisis of minority culture inheritance and preservation is more acute than ever before in history.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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