A REVIEW ON MATERIAL PROCESSING OF ALUMINIUM METAL MATRIX COMPOSITES

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ABSTRACT

In this paper, the various work done by number of researchers for the manufacturing of piston is studied. An overview is given in this paper where the best method for manufacturing piston is analyzed. The various methodsformanufacturing pistons are also explained in this paper. In the present work investigation about the effect of Squeeze pressure on the Aluminium alloy is studied.

Key words: Squeeze casting, Die, Aluminium alloy, Metal Matrix Composites

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INTRODUCTION

Aluminium alloyshave the potential for excellent castability, weldability,light weight good thermal conductivity, high strength at elevated temperature and excellent corrosıon resıtance.Therefore, they are well suited for aerospace structural applicatıons,automobile industry ,millitaryapplicatıons etc.Squeeze castıng processhas found production applications of non ferrous metals like aluminium, brass, lead. Squeeze castıng technique employed for two reasons .

1)Reducing the amount of entrapped gases .
2)Reducing the amount of solıdıfıcatıon shrınkage.

SQUEEZE DIE CASTING

Die casting is a metal casting process by which the molten forcing under high pressure into a mold cavity. The mold cavity is created using two hardened tool steel dies which have been machined into shape and work similarly to an injection mold during the process. Most die castings are made from non-ferrous metals specifically copper, aluminium, magnesium based alloys. It is especially suited for a large quantity of small- to medium-sized castings. Die castings are characterized by a very good surface finish (by casting standards) and dimensional consistency.

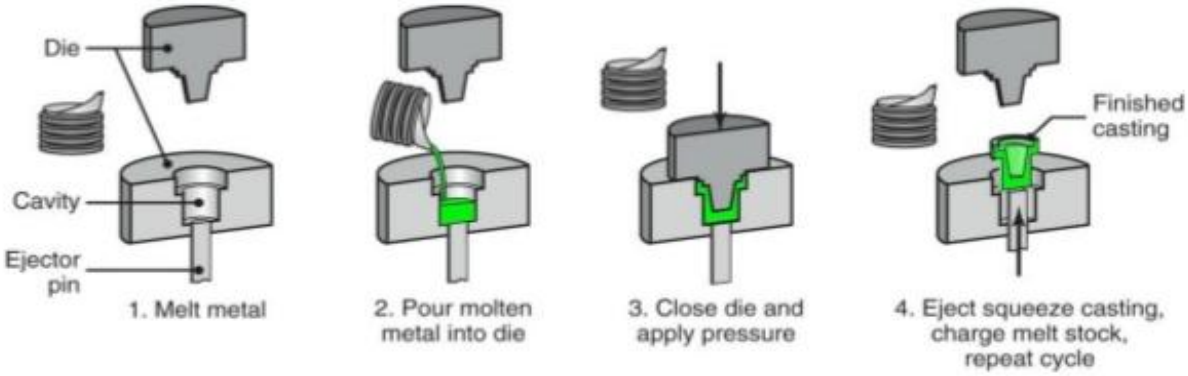

Fig.1 process outline of squeeze die casting

ANALYSIS OF PISTON MANUFACTURED BY VARIOUS PROCESSES OBSERVATION

The preparation and characterization of squeeze cast-Al–Si piston alloy reinforced by Ni and nano-Al_2O_3particles[1] was analyzed by Hashem F. El-Labban, M. Abdelaziz, Essam R.I. Mahmoud. The ultimate tensile strength (UTS) of the resulted materialscan increase by increasing the Ni content to almost 10%. This results in the improvement in mechanicalproperties of aluminium alloy.

The development and analysis of al-matrix nano composites fabricated by ultrasonic assisted squeeze casting process[2] was analyzed by mayureshsingha, r.s. ranab, rajeshpurohitc, krishnkantsahud. The aluminium based metal matrix was fabricated using ultrasonic squeeze casting. The microstructure examination showed that small and very tight morphologies have been obtained in squeeze casting with respect to stir casting technique.

The effects of processing parameters on the microstructure and mechanical properties of modified B390 alloy in direct squeeze casting[3] was analyzed by D.Y. Maeng, J.H. Lee, C.W. Won, S.S. Cho, B.S. Chun. mechanical properties such as hardness and tensile strengths were greatly improved as the applied pressures were increased. This was due to not only refinement of Chinese script but also due to the increase in solubility of solute atoms and decreases of inter-dendritic pores by applied pressure.

The Effect of Squeeze Cast Process Parameters on Fluidity of Aluminium LM6Alloy[4] Vignesh R, Sanjay Gandhi M, VigneshAandRajarajan P The maximum fluidity of Aluminium LM6 alloy during squeeze casting was obtained under the applied pressure of 30 MPa at a pouring temperature of 750°C. The Fluidity of Aluminium LM6 alloy during squeeze casting increased with increase in molten metal pouring temperature.

AN OVER VIEW ON VARIOUS METHODS OF MANUFACTURING ALUMINIUM ALLOY PISTON

A) CENTRIFUGAL CASTING PROCESS

Centrifugal casting is a casting technique that is typically used to cast thin-walled cylinders. It is used to cast such materials as metal, metal alloys. It is noted for the high quality of the results attainable, particularly for precise control of their metallurgy and crystal structure. Unlike most other casting techniques, centrifugal casting is chiefly used to manufacture stock materials in standard sizes for further machining, rather than shaped parts tailored to a particular end-use.

As per the journal Fabrication of aluminium composites reinforced with carbon fibres by a centrifugal infiltration process[5] proposed by M. Sánchez , J. Rams, A. Ureña, Centrifugal infiltration is a suitable technique for the fabrication of aluminium matrix composites reinforced with carbon fibres from preforms made of short carbon fibres either with uncoated fibres or with electroless nickel-coated fibres.

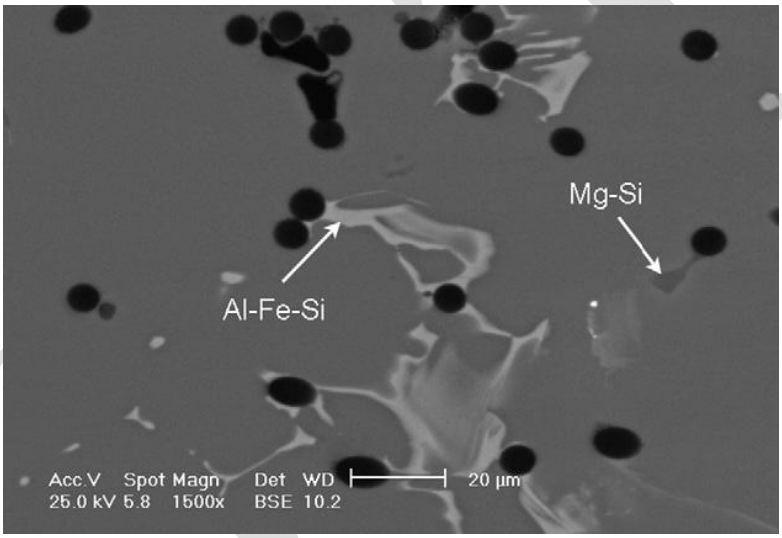

Fig.2 Microstructure of the composite fabricated with a preform of non-pressed uncoated fibers and pre-heated at 600 _C in an auxiliary furnace.

The following experimental model shows the micro structure of aluminium alloy manufactured by centrifugal casting process.

a) Show the grain structure of aluminium alloy which is manufactured by squeeze casting procees, whose grains are tightly packed and the porosity is very less.
b) Show the grain structure of aluminium alloy which is manufactured by conventional casting process, whose grains are packed along with porosity.

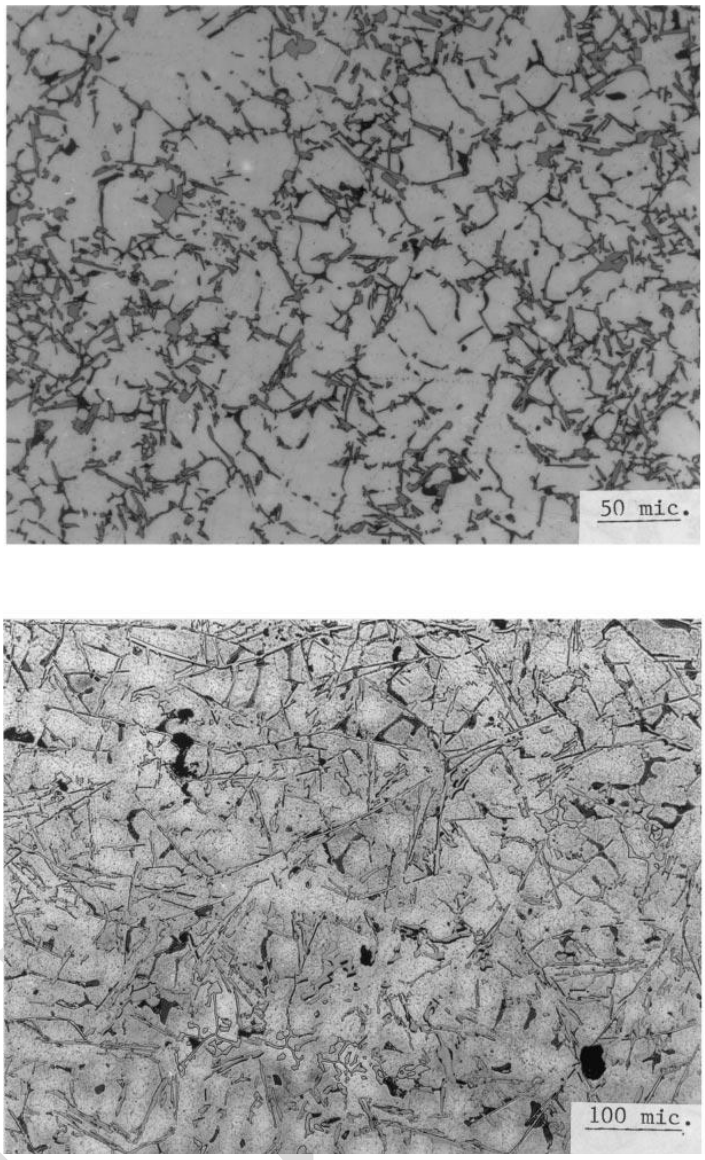

Fig.3 Optical micrographs to show the as-cast structure of LM24 Al±Si alloy [40]: (a) squeeze cast LM24, and (b) conventional as-cast LM24.

B) GRAVITY DIE CASTING

This molding technique is widely used for the manufacture of castings parts made of non-ferrous alloys such as aluminum, magnesium, copper or zinc. This is mainly due to the low melting temperatures not exceeding 1000°C. For this type of casting, metal is poured at atmospheric pressure in a “permanent» mold, made from two machined steel blocks. Cavity, which will form the final part, is machined from solid block. Each block represents an half of the final work piece. The upper mold and the lower mold connected by a parting line determined during the design phase. The parting line position is essential to remove the part without damaging the mold or the piece after the solidification phase.

As per the journal Effect of NaCl as a space holder in producing open cell A356 Aluminium foam by gravity die casting process[6] proposed by S.F. Aida , M.N. Hijrah, A.H.Amirah, H. Zuhailawati, A.S. Anasyida, Open cell A356 aluminium foam was successfully produced by gravity die casting with pore sizes in the range of 204 μm to 224 μm. Pores distribution in A356 aluminum foams was controlled by amount of NaCl space holder. Greater amount of NaCl particles generates interconnected pores. The density of A356 Al foam decreases and porosity increase with the increasing amount of NaCl.

C) STIR CASTING PROCESS

As per the journal Development and Analysis of Al-Matrix Nano Composites fabricated by Ultrasonic assisted Squeeze casting process[2] proposed by Mayureshsingha, R.S. Ranab, Rajesh Purohitc, krishnkantsahu, The total five reading were taken from the different point on the sample and average was calculated. The results of hardness test for Al 6061alloy-Al_2O_3nano composites with 1,2,3 wt. %of nano Al_2O_3reinforcement fabricated using ultrasonic assisted stir casting process and the ultrasonic assisted squeeze casting process are shown in figure.

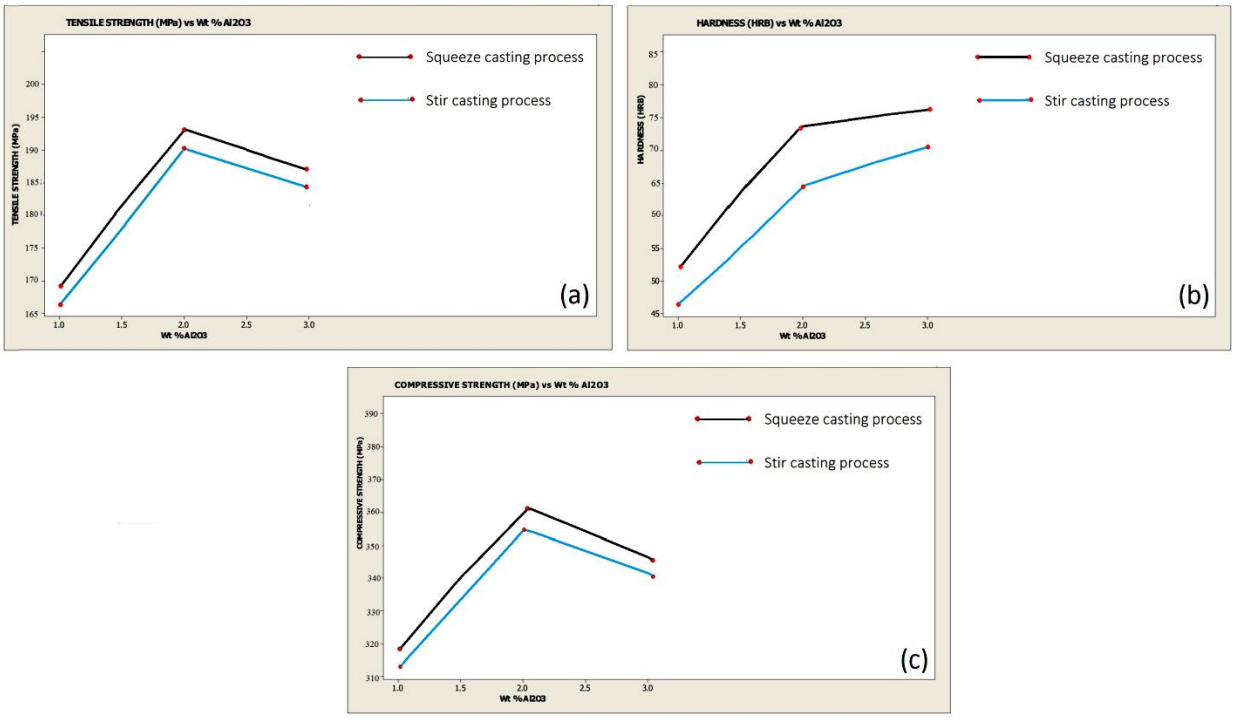

Fig.4 Comparison of (a) Tensile Strength (b) Hardness (c) compressive strength of AMNCs with wt% of nano Al_2O_3 variation ultrasonic that stir casting process and with ultrasonic assisted squeeze casting process.

D) SQUEEZE DIE CASTING

Squeeze casting is a combination of casting and forging process. The process can result in the highest mechanical properties attainable in a cast product. The development of squeeze casting process, can usher in tremendous possibility for manufacturing of components of aluminium alloys, which are not properly commercialized as yet. It can also be effective in for import substitution of critical components. The process starts when the molten metal is poured into the bottom half of a pre-heated die. As soon as the metal starts solidifying, the upper half of the die closes and starts applying pressure during the solidification process. The extent of pressure applied is significantly less than that in forging. Parts of great detail can be produced. Coring can be used in tandem with the process to form holes and recesses.

As per the data from the journal Effect of Squeeze Cast Process Parameters on Fluidity of Aluminium LM6 Alloy[4]Vignesh R1, Sanjay Gandhi M, Vignesh Aand Rajarajan P states that the pouring temperature and pressure for casting process effects the fluidity property of aluminium alloy.

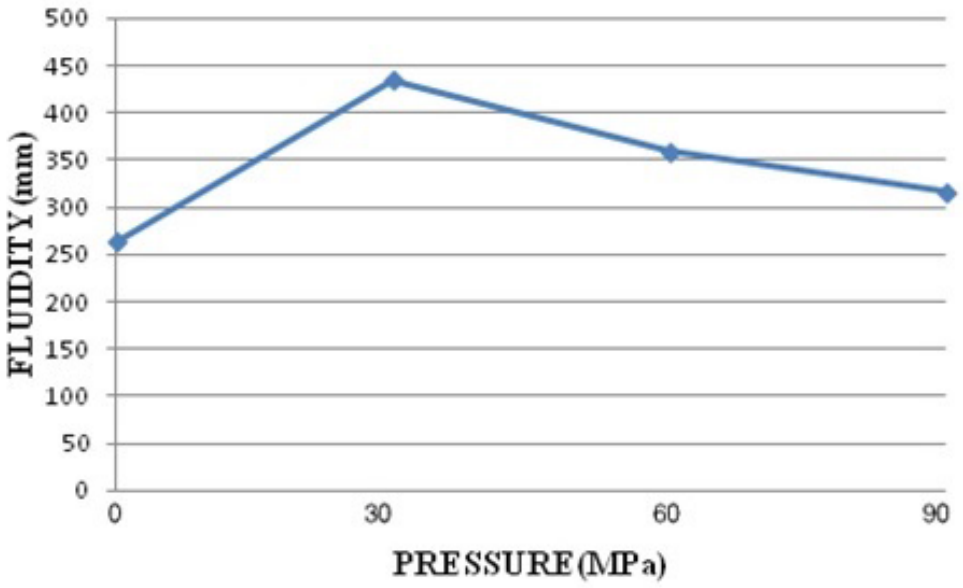

Fig.5 Variation of fluidity of squeeze casted Aluminium LM6 alloy with various squeeze pressure at pouring temperature of 750°C.

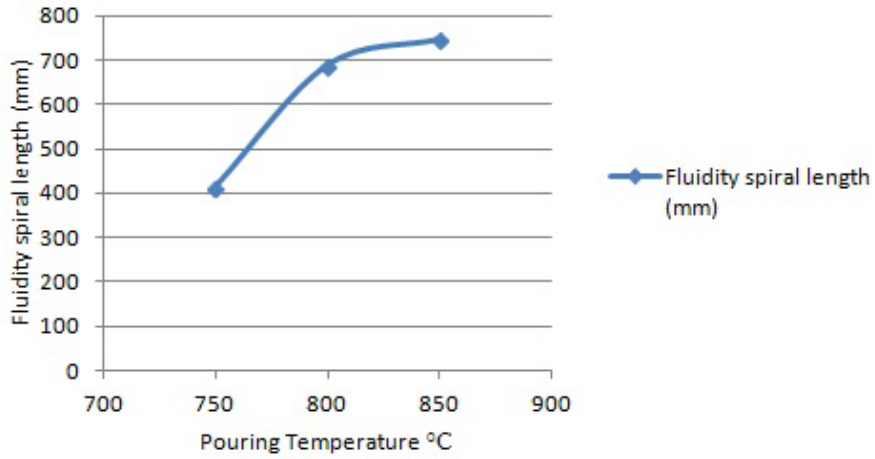

Fig.6 Variation of fluidity of squeeze casted Aluminium LM6 alloy with the pouring temperature at a squeeze pressure of 30 MPa.

WEAR PROPERTY ANALYSIS OF ALUMINIUM ALLOY

As per the journal Study on wear properties of aluminium–silicon piston alloy by M.M.Haque, A. Sharif[20] states the difference in mechanical property of aluminium alloy with varying conditions.

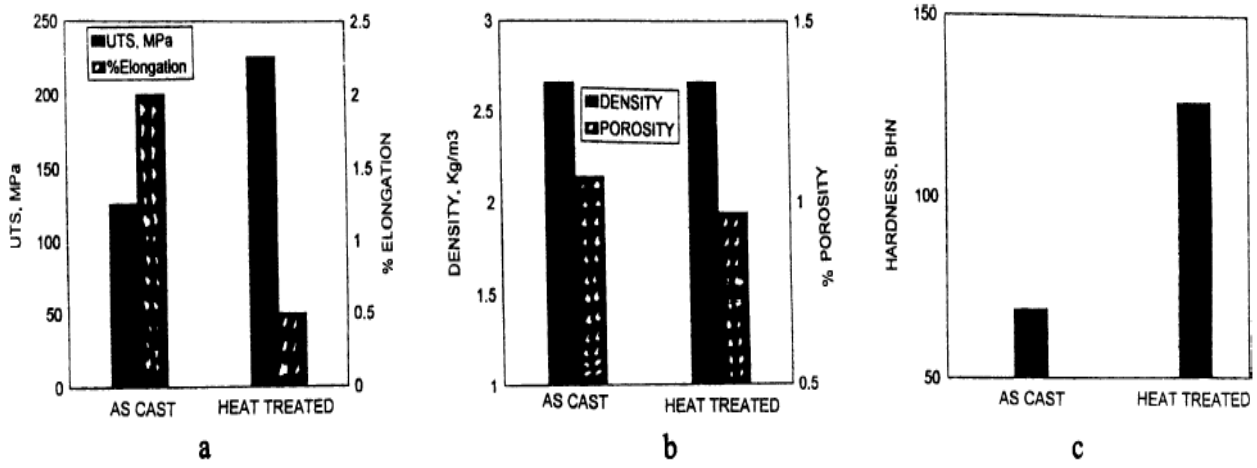

Fig.7 Properties of Al–Si piston alloy: (a) UTS and % elongation; (b) density and % porosity; (c) hardness for both as-cast and heat treated conditions.

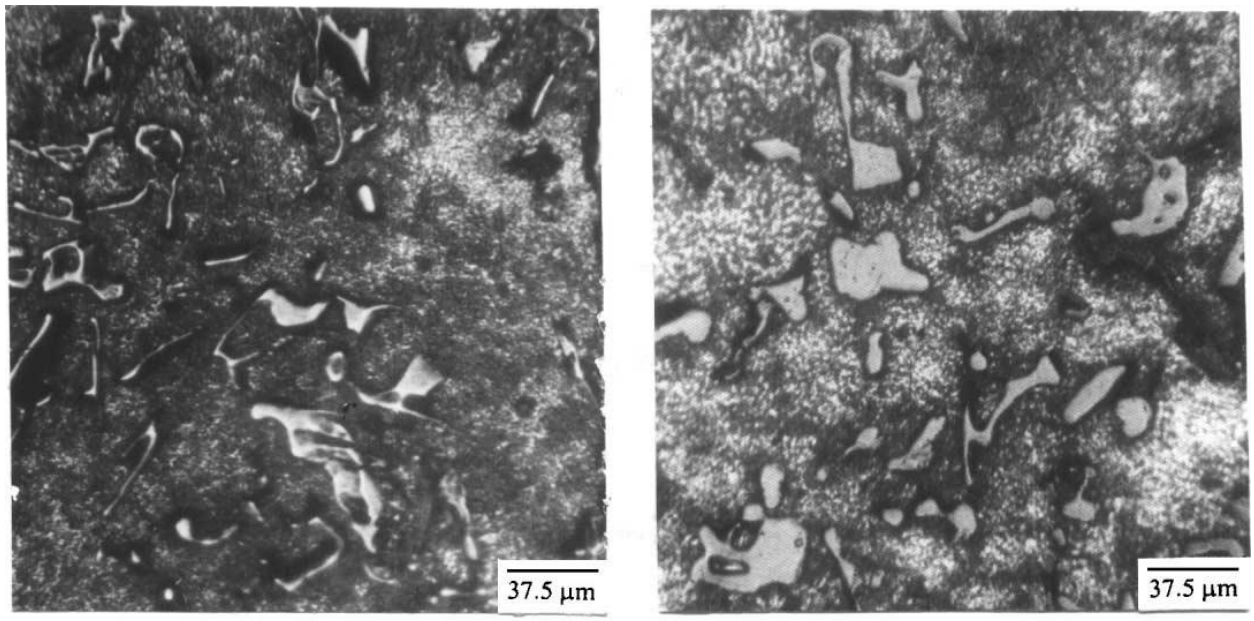

Fig.8 Microstructures of Al–Si piston alloy: (a) as-cast; (b) heat treated specimens.

CONCLUSION

Thus the various journals on piston manufacturing is being studied and the following are determined. The mechanical properties i.e., tensile strength, hardness compressive strength of the piston is being improved in squeeze die casting process.The grain structure of the piston manufactured by centrifugal casting process is improved up to 78% when compared to piston manufactured by squeeze die casting process.The porosity formed during casting process is reduced up to 90%.The fluidity property of aluminium LM6 is improved at 750°C temperature. Along with heat treatment process the aluminium alloy gains a greater value of hardness.

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