



# ON TYPICAL MATERIALS ACTING AS THE DIVIDING STANDARD OF THE DEVELOPMENT STAGES OF HUMAN SUBSTANCE CIVILIZATION

Bangwei Zhang\*

College of Physics, Hunan University  
Changsha, China

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## ABSTRACT

During more than three million years, the substance civilization of human society went through the Stone Age, the Bronze Age, the Iron Age, the Steel and Cement Age, and the Silicon Age. At the beginning of the new century, the human society has entered into the Nanomaterials Age, which indicates that a completely new substance civilization of human society has started. This paper analyses and discusses why the typical materials serve as the only standard for dividing the eras of the substance civilization of human society. The author argues about the subject of dividing the substance civilization of human society. The goal is to initiate broad and thorough discussion of that subject so as to get a rather thorough understanding about it.

## KEY WORDS

substance civilization, human society, typical materials, dividing standard, production relations, the tool of production, three-age system theory, six-age systems theory

## CLASSIFICATION

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\*Corresponding author, *η*: [zhangbw@hnu.edu.cn](mailto:zhangbw@hnu.edu.cn); +0731 88822715;  
College of Physics, Hunan University, Changsha 410082, China

## **INTRODUCTION**

The substance civilization of human society has passed a very long period of time. Usually it estimates more than 3 million years. After breaking away from eating raw birds and animals for a very long period of time, the substance civilization of human society has started to develop from a very low level to the present highly developed brilliant stage just through the efforts and struggles of the whole humankind. How to divide the development stages of the substance civilization of human society, and what should be the standard for such division? These are very interesting questions. It must be pointed out that these questions are of no uniform answer but are very diverse from each other. One can say that since opinions vary, no unanimous conclusion can be drawn.

## **TWO APPROACHES**

In general, one can find two approaches to dividing the development stages of human society. First approach is the so-called theory of the five societies. These societies are the Primitive Society, the Slave Society, the Feudal Society, the Capital Society and the Socialism & Communism Society [1]. This approach is well known in China and overall in socialist countries. It is obvious that such an approach for dividing the stages of the human society follows mainly from the ideology and political viewpoint or production relations. Moreover, there is a conflict phenomenon inherent to that division, the so-called conflict between the advanced social system and backward social productive forces. After the famous Soviet revolution in 1917, this phenomenon is still existent and has not been resolved. On the one hand, this is an intrinsic characteristic of a socialist country. On the other hand, the development of the substance civilization in the socialist countries still lacks that of the average capitalistic country. As is well known, currently developed countries are capital countries. That is to say, the backward social system has the advanced substance civilization, but the advanced social system has the backward substance civilization. Therefore, such kind of division cannot represent, cannot describe completely and exactly all the real facts and all aspects for the development stages of the substance civilization of human society. Such conflict phenomenon, of course, cannot be explained by the corresponding approach.

Since the dissolution of the socialist systems in former Soviet Union and Eastern European countries and their transformation to capitalistic systems, a new phenomenon occurred. The development of society is considered not as a forward, but as a backward in these countries. It should be obvious that such a phenomenon of backward development of a society is also difficult to explain using stated division.

Everything in the development of the world should be forward but never backward. Who could see a tree grew up to 5 meters then decreased down to 4 or 3 meters? Or who could see that a normal and healthy person who was 30 years old yesterday, but becomes a ten year old child today? As for the substance civilization development in the whole world, it is also impossible from a very high level back to a very low level, for example back to the Stone Age. Such a backward phenomenon cannot happen unless the Earth is destroyed by an accidental destruction and all the present, highly developed substance civilization have been shattered instantly.

Of course, such a scenario does not include social events. How to explain the mentioned unusual social event? We know that such as a backward phenomenon in the development of social systems did not occur at the time when this kind of dividing standard was originally proposed by Marx and Engels. They, of course, were not able to consider and explain it, but nowadays people should be able to explain it clearly. It must also be emphasized that we do

not want to criticize or to deny the truth for the kind of division from the ideology and political viewpoint. But for dividing the development stages of the substance civilization of human society we will use different opinions, to be stated further in the text, because they agree with all of facts for the development of substance civilization of human society. Moreover, the aforementioned conflict phenomenon can be explained consequently.

In fact, the original proposers of the mentioned dividing standard, Marx and Engels, also proposed the second kind of opinions for dividing the substance civilization of human society, stated from the point of view of the tool of production but not from the production relations. Marx wrote: “However little our written histories up to this time notice the development of material production, which is the basis of all social life, and therefore of all real history, yet prehistoric times have been classified in accordance with the results, not of so-called historical, but of materialistic investigations. These periods have been divided, to correspond with the materials from which their implements and weapons were made, viz., into the stone, the bronze, and the iron ages.” [2]. This is so-called the Three-age system theory. From these words, we can see three points obviously. First, Marx and Engels criticized most of the history books because they neglected the importance of the development of substance production. That neglect was wrong because it was not in agreement with the facts of development of humankind. Secondly, Marx and Engels proved incontrovertibly that the prehistoric period can be divided into the Stone, Bronze and Iron Ages. And thirdly, Marx and Engels proposed clearly that the standard of division were materials of manufactured tools and weapons but not the history.

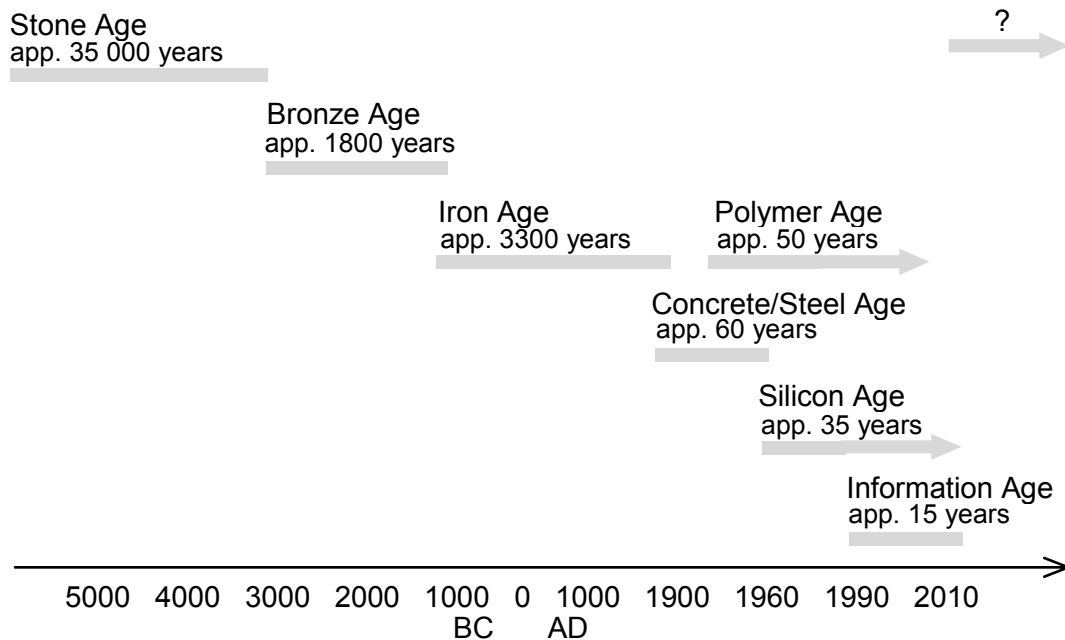
It should be pointed out that Marx and Engels did not prove and emphasize which one of the aforementioned two divisions they prefer, or when one should use the division of the five societies, and when the theory of three ages. But, most of the Marxists claimed to be sure that Marx and Engels usually preferred the kind of division of the five societies. Just as an example see the paper of Du and Liu [3].

We are sure that the second kind of division for dividing the substance civilization of human society is the most suitable, because we do not want to consider the situation of the various classes and the production relations and we just consider the development of the substance of civilization in the stages of human society. We will describe and analyze it in detail further in the text.

## **DIVIDING STANDARD**

Before we go into details of the description and discussion, let us write some words about the contemporary situation, with a lot of arguments and rather confuse status for dividing the stages of the substance of civilization of human society. For example, as was once said, “up to date, the human society went through the stone age, the bronze age, the iron age, the steam age, the electronic age, the electron age, etc.” [4]. Another argument is that “the course of human society was been divided the stone age, the iron age, the bronze age, the hand grinder age, the machine industry age, the electron information age, etc.” [4]. The third argument is “some researchers proposed such as ‘the age of global peace and development’, ‘the age from confrontation to relaxation’, ‘the age from two poles to multiple poles’, ‘the age of economic globalization’, ‘the age of knowledge economy’ et al. new says.” [5]. The fourth argument is that the whole human history could be divided into “the Stone Age, the Bronze Age, the Iron Age, the Concrete/Steel Age, the Polymer Age, the Silicon Age and the Information Age.” [6]. The fifth argument is that the present age is “Information Age” by Bill Gates [7], etc. The appearance of such chaotic situation is lack of unanimously recognized standard for dividing the development stages of human substance civilization.

Our point of view is that the standard for dividing the stages of the substance civilization of human society is based on the point of view of the tools of production but not of the production relations. Stated differently, the standard for dividing the stages of the substance civilization of human society is the materials of manufactured tools and devices. This is in agreement with the point of view from Marx and Engels [2], because they used the materials of manufactured tools and weapons to divide the Stone, Bronze and Iron Ages at least as mentioned previously. The scholars from the Cornell University also hold the same opinion (Fig. 1). However, they introduced the Information Age to represent the so called Late-Silicon Age, which is not based on the materials. In addition, several Ages overlap, which also seems inappropriately.



**Figure 1.** Division of human society from Cornell University [6].

Making a general survey of the developing history of human society, the development and their application of materials always are the milestone for the civilization and economic progress. The introduction and application of a new type of materials has always caused the important change for human society. The reason is obvious since everything is either made or depends on materials. Not to mention the food eaten, clothes worn, things utilised, all of the devices, all of the tools, and various weapons which all cannot be manufactured without materials. Even the so-called spiritual food such as books, films, radio, television, internet, etc also cannot work without materials, but must rely on them. Materials are the bases of all things including people's life, human progress and the substance civilization of human society.

Use of the typical materials to designate the stages of the substance civilization of human society just reflects the basic role of materials in the process of development for human society, because any name of devices, articles and things, or some kind of abstract name cannot replace it. We know that a lot of great devices, buildings and other things were created by our humankind, such as The Great Wall, The Pyramids, various skyscrapers, various great bridges, automobiles, trains, planes, spacecrafts, satellites, internet etc. They are all important symbols for the substance civilization of human society, and we are proud of them. However, who can imagine that such great things can be created without materials? Or from the other point of view, can we have The Great Wall Age, The Pyramid Age, or automobile, train and plane age? Of course, we cannot do so though sometime some people has referred to the world as to the automobile age or plane age.

Not using the name of some great things to represent the stages of the substance civilization of human society, are we able to use some kind of abstract name to represent it? We do not think so as well. Names as Age of knowledge, Economy Age or Information Age are frequently seen in the various places and situations for naming the Late-Silicon Age. We do not want to analyse the content of these names completely, but just to analyse why we cannot use them to represent the present age of human society we live in. In this article we limit us to discuss the name of Information Age.

Who and when named the Information Age first? It is difficult to say. There is a lot of books about the Information Age. Let us mention the rather famous book “The road ahead”, published in 1995, written by Bill Gates [7]. Title of Chapter 2 of that book is “The start of the Information Age”. Gates did not illustrate the initial time of the Information Age, and also did not define it. But his main description is about the Information Highway, that is the today’s internet. From the internet, some definition of Information Age can be found, for example “A period beginning in the last quarter of the 20th century when information became easily accessible through publications and through the manipulation of information by computers and computer networks.” [8]. Whether the information highway, the computer network or the internet, they all mention the same thing, which is just about transmitting information: words, papers, books, pictures, music, films etc. using lines or wireless network, computers and other equipments, so people can get information easier and faster than ever before. Of course, the internet is not the only element, but there are many other kinds of things, devices or equipments included in the elements of Information Age. Just regarding the internet, the key element is the computer. For the computer, people well know that, without software, operating system (OS) and other application software, it is of no use even if you have the best computer. That is to say, the software is very important for the computer. No one wants to omit it but not everyone emphasises it. However, not too many person pay attention to the inverse problem that for the development of computer the hardware, as we usually calls it, is more important. Reason for that is that people either do not understand it very well or omit it consciously or unconsciously. In fact, even if you have some advanced Vista or Windows 7 Ultimate Operating Systems, your computer ca not operate and run at all if you only have an IBM Computer XT or a computer with a 386 central processing unit (CPU, the most important element of a computer system). To compare hardware and software, the hardware of a computer is the basis, the most important part because the software will be accompanied by the development of the hardware, but the inversion is not true.

Of course, the development of computer mainly depends on the progress of its CPU and hard disk. The CPU depends on transistors. From the very beginning to present time, the key element of CPU went through several stages: the electronic tube → transistor → micro integrated circuits (IC) → submicro IC → nano IC. We do not want to mention all of these, but just to mention the development of Intel’s CPU. From Intel’s first CPU (4004), containing 2300 transistors, which was released in November 1971, to Intel® Core™ 2 Extreme quad-core QX6850 CPU, released in July 2007 with 582 million transistors, the number of transistors in CPU increased 253 000 times in the past 35 years. Regarding the increase of the CPU speed, the following comparison was made: if the speed of an automobile increased since 1971 at the same rate as the chip speed did, you would now be able to drive from San Francisco to New York City in less than 10 seconds. Here the assumption is that the car’s speed in 1971 was 60 mph and the distance from San Francisco to New York is 3000 miles. And the properties of CPU such as the speed, cache and million instructions per second (MIPS) increased similarly, from 108 kHz, 640 Bytes and 0,06 MIPS to 2,66-3,0 GHz, 64 Gb and 11 000 MIPS, respectively, in the same period with corresponding rates of 280 thousands, 100 million and 1,7 million respectively [9]. Moreover, the price of a

transistor in CPU unparallelly decreased: from US\$ 1 for each transistor in 1968 to US\$  $4 \cdot 10^{-7}$  in 2002, decreasing in total 2,5 million times. What caused that? The cause is just the miniaturization of transistors in CPU [10, 11]. It was caused by the rapid decrease of the typical size that is the grid length of the transistor, which was reduced from 10  $\mu\text{m}$  in 4004 to 65 nm in Core™ 2 Extreme quad-core QX6850 CPU. Though the decrease of the typical length of transistor in CPU is only 154 times, that reduction resulted in the brilliant progress of information technology (IT) and relevant industries, so as to produce an earth-shaking change in the world. It is impossible to imagine that such progress could take place without the development and progress in the silicon and other related materials, such as the gate dielectrics [12, 13]. That is to say, the materials progress resulted in such IT progress.

Similarly one can analyse the computer's hard disk drive. From the first IBM hard drive RAMAC in 1956 to present ones, half a century passed. The storage capacity of RAMAC is 4,4 MB, and it was made of fifty 24-inch aluminum plates with total weight of 2140 lbs (970 kg). Today it cannot be mentioned in the same breath, and we just mention the hard drive of Barracuda 7200.10 with 750 Gb, released by Seagate in April 2006. Its diameter is 3,5 in (9 cm) and its weight is only several ounces. Overall the data storage capacity increased 150 000 times during the past 50 years. This is a consequence of the increase in the area density of disk, from  $2 \text{ Kb/in}^2 = 2 \cdot 10^{-6} \text{ Gb/in}^2$  for the first RAMAC hard drive to  $1 \text{ Tb/in}^2$  reported in October 2006 [14], the increase of  $5 \cdot 10^8$  (500 million) times. And the decisive factor for such an increase is the development and progress of materials for magnetic head and disk. Just because of the progress of the magnetic recording materials, the magnetic head went through several stages: magnetic oxides  $\rightarrow$  MR  $\rightarrow$  CIPGMR  $\rightarrow$  CPP  $\rightarrow$  GMR  $\rightarrow$  HAMR (Heat assisted magnetic recording) [15, 16]. The facts show that without the development and progress for the magnetic materials for magnetic head and disk, there would be no such progress of computers in the world.

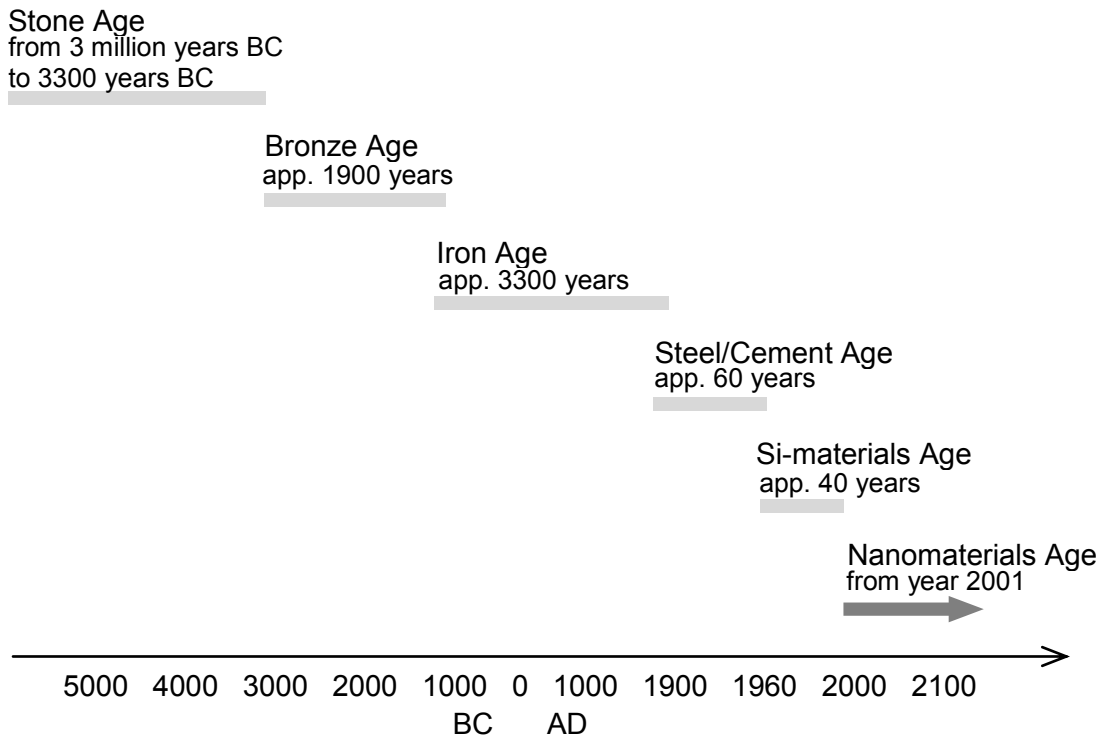
All of the stated facts and analyses contribute to the fact that the development and progress of computers was caused mainly by the advance of materials and improvement of process technologies. We cannot use the production relations to explain such world-shaking change because one can argue that it is rather obvious that during the last half of century, in most of the countries including China, UK, France, Germany, Japan, USA etc. the social systems, that is their production relations, did not change. On the contrary, the production relations for the former Society Union and the East European Countries all were backward from socialist systems to capital systems. Such change did not bring about any obvious effect to the progress of the computer in the whole world.

As mentioned previously, for the substance civilization development in the whole world, it is impossible to change from a very high level to a very low level, for example back to the Stone Age. Even though the development would be affected and would become rather slow because of some reason, for example because of the change from socialist to capitalist system in the former Soviet Union and Eastern European Countries, the substance civilization development in the whole world still develops forward but never backward. Its development process has always been forward. The mentioned conflict phenomenon will not appear, so it is not a problem from such a point of view. But for the five society system theory, it is a problem that is difficult to explain.

## **TYPICAL MATERIAL**

There are tens of thousands of kinds of materials. Of course, not every material can be used for such division. Only a very few man-made materials can do so, they must be the typical materials. In our opinion, only the materials which satisfied several conditions can be used

for dividing the substance civilization of human society. Such conditions are that the materials must be human made; the materials must cause huge change of the whole world; and the materials must stand for a long period of time in human history. Therefore wood, ceramics, glass, plastics and polymer cannot be used to divide the stages of human society. Up to date, we have six such typical materials, which are stone, bronze, iron, steel/cement, silicon and nanomaterials. Figure 2 shows our division for the substance civilization of human society with the six typical materials. Table 1 lists the corresponding date ranges of the Ages. This is the six-age systems theory on division of the substance civilization of human society.



**Figure 2.** The proposed division of substance civilization of human society by the author. Time axis is not in scale.

**Table 1.** Division and date range of substance civilization of human society.

Age	Time period
Stone Age	3 million – 3300 years BC
Old Stone Age	3 million – 10 000 years BC
Lower Paleolithic	3 million – 0,2 million years BC
Middle Paleolithic	0,2 million – 35 000 years BC
Upper Paleolithic	35 000 – 10 000 years BC
Middle Stone Age	10 000 – 6000 years BC
New Stone Age	6000 – 3300 years BC
Bronze Age	3300 – 1400 years BC
Iron age	1400 years BC – 1900
Steel and Cement Age	1900 – 1960
Si-materials Age	1960 – 2000
Nano Materials Age	2001 –

Here we just give a short introduction to the contents and reasons for determination of six typical materials for the six-age systems theory in order to understand the Fig. 2 and Table 1 more clearly. They were described and discussed in details elsewhere [17, 18].

In the means used for access to food to sustain life, there was no significant difference initially between our ancestors and the parted ways animals, also only using hands and teeth. This was a very long period.

Gradually, our ancestors recognized using the natural wooden sticks and stones for access to food, and for protecting themselves because of their intellectual development, which was significantly larger than of animals. It is considered that there was a long period during which our ancestors gradually learned how to use tools. They did not only understand how to pick up the large stones and sticks to hunt animals, but also gradually recognized using their collected big stones with sharp edge to tear open fur, and to slit tendons and meat of the preys besides using their hands and teeth.

In the long process of how to learn using tools, our ancestors recognized that some stones, e.g. flints, could produce the sharp edge when broken. Then, they gradually developed understanding that the stones with sharp edges could be obtained using a stone to struck another stone. These are the chipped stones as the historians called, and that is the origin of human manufacturing of tools.

From using the natural tools to their initial manufacturing chipped stone tools, there is a great qualitative leap in the whole development history of the human substance civilization. This period was rather long. Since then, humankind has relied on the self-made man-made materials (the exception being the use of natural stones because of the very low productivity and impossibility to make man-made materials in the Stone Age) and the various kinds of tools and implements made by such man-made materials, developing the substance civilization, through one after another brilliant stage. The initial point for dividing the developed stages of the human substance civilization was from the day that human manufactured the chipped stone tools.

The Stone Age was a broad prehistoric time period during which humans widely used stone for toolmaking. The date range of this period is ambiguous, disputed, and variable according to the region in the world. However, in general, it is considered that this period began around 3 million years ago, starting with the first hominid tool-making in Africa [19, 20]. Some archaeological teams discovered recent years the earliest direct evidence of stone tool manufacture and use back to 2,6 million years old [21]. Therefore, the Stone Age started in 2 to 3 million years ago as proven by the excavated stone implements.

According to the manufacturing level for the stone tools and appliances, the Stone Age is usually divided into three sub ages: the Old Stone Age (Paleolithic), the Middle Stone Age (Mesolithic), and the New Stone Age (Neolithic).

The Old Stone Age is divided the Lower Paleolithic, the Middle Paleolithic and the Upper Paleolithic, which corresponded roughly the Homo habilis and Homo erectus, early Homo sapiens and the advanced Homo sapiens stages respectively in the human evolution itself. The date ranges for them are listed in the Table 1. They were all confirmed by the archaeological excavations [22-24].

The common features for the man-made artifacts such as Acheulian hand ax, single-stage cores and flakes in the Mongolia's Yahe Hill district in this period are rough processing and simple shaped.

The Mesolithic is characterized by small composite flint tools (microliths and microburins) in most areas [23]. Indirect striking small stone process has become more mature technology,



the composite tools such as embedded thin flakes in the bone and wood stalk arrow and knife appeared. The grinding stone tools have been appeared also. The dart, cone and other bone implements became more well practice. Arrows were the most important invention in the Mesolithic. Because of its long range and speed, arrow became the main hunting tools at that time. The earliest wooden bow is discovered in the Northern Germany and is dated about 9000 BC [25, 26]. Two points in this period should be emphasised here. The first is that our ancestors invented the ceramics with use of fire to burn clay [19]. The second is that people's way of living changed from the mobile scattered living to that of the settlers [27].

The main mark of the Neolithic was that the use of grinding stone tools and implements was rather widespread [19]. Our ancestors mastered very skillfully the method that first selects the suitable stone materials to manufacture a prototype of stone, and further includes repeated grinding and polishing of the stone implements with the sand and water against a whetstone. It should be stressed that the history known as the "revolution of agriculture" appeared during this period of time. Around 12 000 years BC, there was a great change of the Earth climate, because of which the prevalent way for acquiring and hunting food became more and more difficult, thus promoting the conversion to agricultural production. Hence the agriculture became the main means of subsistence, of and the productive sectors [19]. People domesticated some types of wild animals into livestock and some types of wild plants for the cultivation of cereals. Therefore tillage technology began to emerge. Of course, this is a milestone in the process of human substance civilization.

In the later Neolithic, our ancestors felt that only the stone tools were unable to meet the need for the development in agriculture and handicraft industry. The stone tools were rather difficult to excavate and overturn the slightly hard land, besides that the efficiency was rather low using the stone tools in the plowing. In addition, the process of war asked strongly for new weapons, the sharper and more powerful weapons than the stone weapons. It is evidently that the stone tools became the main barriers to production and social development. Our ancestors had to find new man-made material for further development of our civilisation. That was Bronze, so the Bronze Age came. First, the ancient people discovered the natural copper in the rich copper ore region, which is almost pure and has characteristic red color of the metal copper, so as to call it red copper. People found from the archaeological excavations in recent years the evidence of the use of red copper [28]. The red copper is not man-made, and has an obvious shortcoming, that it is rather soft. Later on, people found the mixed mines of copper and tin, or copper and lead, in some districts. The blacksmiths at that time calcinated such copper ore with charcoal, and produced Cu-Sn or Cu-Pb alloys. The color of Cu-Sn alloys is green gray, so as to call it bronze. The casting property, hardness and strength of bronze are much better than those of pure copper. The invention of the casting technique of bronze was another important milestone in human history of the development of material civilization. In 1975, a bronze knife was unearthed from the Majiayao culture sites, Ganshu province, which dated 3000 BC years ago [28]. With combination of other archaeological data, it is estimated that humans entered the Bronze Age about 3300 BC.

The shortcomings of bronze come from two aspects. The copper ore is in general not abundant in the Earth, thus the copper production is not high, and extensive use is restricted. In addition, copper has rather poor strength and hardness. It was difficult to meet the needs for expansion of agricultural production by deforestation, excavation and mining the underground mineral deposits, especially for creating more tenacious sharp weapons. Our human ancestors deeply felt to find better than copper metal materials for development. It was iron. The iron ores are abundant in many regions. The iron ware was hard, tough and sharp, and suited far better than stone and bronze. Humankind recognized the iron first from the iron meteorite. An iron-bladed bronze tomahawk dated back to the 14th century BC was

excavated in 1972, and confirmed that the iron was manufactured by the siderite [29]. In order to use iron, our ancestors must master the iron-smelting technology because the melting point of iron is 1535 °C, which is much higher than the melting point of copper (1083 °C). Through practice by practice in a long term, they finally mastered the iron-smelting technology, as well as how to use the pig iron turned to the wrought iron. So, they could produce various iron tools and weapons though up until now we are still unable to determine who exactly was the first inventor of the iron-smelting technology. Archaeological excavations conducted recently in India [30], in the West China [31], and in West Africa, confirmed that people in these districts used the iron since 1800 BC, 1200 BC and 1000 BC, respectively. So, one can infer that the world in general has access to Iron Age since about 1400 BC. The invention and its application of the iron materials was another remarkable milestone in the development of human society of substance civilization. Up to the end of the Iron Age, the human substance civilization reached modern high degree of well-developed starting point.

The aspirations for seeking a better material than iron come from three aspects. The first is the inherent shortcomings of iron: it easily rusts, is brittle and of poor plastic property. Because their cut properties and other process properties are not good but rather worse, it is very difficult to process them into various complicated shapes of devices regardless of the pig iron or wrought iron. The second is that the new and developing bourgeois was anxious to rapidly develop their production force and wanted to produce many kinds of goods for average people in order to prove that they were more superior to the feudal class and to confirm and their political power just seized from the feudal dynasty not too long ago. The third is that the natural instincts of humankind pursue the unknown things besides truth. The iron materials cannot satisfy the substance and cultural demand and requirement for the humankind, and became the main factor for impeding social development. People at that time certainly wanted to invent a better kind of materials than iron in order to satisfy their desire and demand of development of substance civilization. This new kind of materials was steel and cement. During the iron age, the important steps for inventing steel include: the enhance of the furnace temperature; using the process usually called the “folded hundred times steel” method to make the surface layer of iron artifacts became a low carbon steel; development of the smelted steel with crucible, producing the “Wutz steel ”; and the Bessemer process with blowing air through molten pig iron to oxidize the material and separate impurities. Thus, a large quantity of high grade steel was produced mainly in England and in Europe. Various shapes of steel materials were produced step by step. The tools and weapons were greatly improved. The world production of steel was 28,5 million metric tons in 1900. In the same period, in 1824, Joseph Aspdin invented Portland Cement on the basis of previous inventors. Therefore, the Steel/Cement Age was coming after 1900. After entering the Steel/Cement Age, the substance civilization of humankind strode forward higher level, which resulted from the development of steel. This situation proves once again that the materials are the key and center action for the substance civilization of human society.

Two World Wars happened during the Steel Age. It is no doubt that the World Wars were not from using the steel and cement materials but from the fascists, from their invasions of other countries, from their political ambitions to enslave the people, and from their war insanity. During the War and especially after World War II, people asked for faster and more accurate communications. The steel and cement cannot meet such demand. Only the germanium, and later on the silicium materials are suitable for such needs. Schockley, Bardeen and Brattian invented the first point Ge-transistor in the world in December 1947. The importance of inventing the transistor for the human substance civilization cannot be overemphasised. Since then, the Si-planar transistor CMOS, IC, CPU, computer, cell phone, and a number of electronic equipment and household appliances have appeared, and all of them are dependent

on the high purity of Si-materials. It is unimaginable that the transistors can be produced by using either steel or cement. The transistors must be produced by using the semiconductor materials. Without the advance of Si-materials, there will be no transistor, no IC, no CPU, no computer and no all of electronic devices. So, the development stage of substance civilization of human society entered the Si-materials age. Considering all of the facts using the Si-materials and all of the devices and equipment fabricated by silicon, with which the worldwide semiconductor revenues reached the US\$ 0,8 billion in 1960, we would like to say that Silicon Age began in 1960.

Why we say that the world entered into the Nanomaterials Age from the beginning of the new century? The main reasons include several aspects. First, the nanomaterials and nanotechnology have affected societies worldwide, comprehensively and deeply, including affecting the world's economies, science and technology, military, and human life. Secondly, today's nanoscience not only established its academic status, limited to its own field but extends to nearly all other macro disciplines [32]. Thirdly, only nanomaterials and nanotechnologies can promote industries to solve their own problems and move forward. For example, only the nanotechnologies can continue the miniaturization of transistors and promote further the Moore law. Fourthly, any other materials (steel or silicon) cannot replace the nanomaterials to produce new tools and devices. For example, nanoparticles could be used to seek out cancer cells and then release an attached drug. Bulk silicon materials cannot make this possible and steel and cement are even more powerless. Fifthly, a long period of human history will be affected by nanomaterials and nanotechnologies. Considering that governments from many countries paid extreme attention to the nanoscience and nanotechnology since 2001, the worldwide investments was US\$ 15,34 billion in 2001, the global market size of nanomaterials and nanotechnologies totaled approximately US\$ 7 billion in 2002 and the global trade volume of nanomaterials and nanotechnologies increased rapidly since 2001, we are sure that the Nanomaterials Age started at the beginning of the new century, in 2001.

## CONCLUSIONS

There are many confusing sayings for the stages of substance civilization development of human society. No unanimous conclusion could be found in the literature.

The analyses and descriptions stated indicate sufficiently that the doctrine of five ages for dividing the political systems and social ideology of humankind society cannot describe, at least not completely and exactly, the division of the development of substance civilization of human society.

The division of the development stages of substance civilization of human society must be based on the tools of production and not on the production relations. Only typical materials can be used as alone standard of such division.

The six-age systems theory on dividing the substance civilization of human society has been proposed, the facts and reasons for dividing them and the date of separating two Ages have been described and discussed briefly.

## REFERENCES

- [1] Marx, K.: *A Contribution to the Critique of Political Economy*. Progress Publishers, Moscow, 1977,
- [2] Marx, K.: *Capital, V.1, The process of production of capital*. Progress Publishers, Moscow, 1887,
- [3] Du, J.G. and Liu, S.G.: *Mastering the present time historically from two visual angles*. Journal of Literature, History & Philosophy **5**, 5-12, 2001,

- [4] Liu, D.: *Recognition of the Marxist theory of human liberation historical process*. Wuhan University Journal (Philosophy Society Science Edition) No. 6, 7-14, 1998,
- [5] Wang, J.: *How to comprehend and understand the Marxist concept of the times*. Dynamic Studies of World Socialism January 1, 7-12, 2005,
- [6] Cornell University: *History of Materials Science and Engineering*.  
<http://www.ccmr.cornell.edu/education/ret/terrih/history.html>,
- [7] Gates, B.: *The road ahead*. copyright © Williams H. Gates III, 1995.
- [8] WordWeb Online: *information age*. 2005-2009.  
<http://www.wordwebonline.com/search.pl?w=Information+age>,
- [9] Intel: *Microprocessor Quick Reference Guide*.  
<http://www.intel.com/pressroom/kits/quickreffam.htm>, 2006,
- [10] Zhang, B.: *Is Moore Law going to be Valid in future?*  
Ziran Zazhi (the Shanghai University) **26**(1), 50-55, 2004,
- [11] Zhang, B.: *Miniaturization of Transistors and Progress in Science and Technology*.  
Journal Hunan University (Social Sciences) **20**(5), 112-118, 2006,
- [12] Zhang, B.: *High k gate dielectric and materials Si Nanotransistor*.  
Micronanoelectronic Technology **43**(3), 113-120, 2006; **43**(4), 161-166, 2006,
- [13] Esener, S.C. et al.: *WTEC Panel Report on The Future of Data Storage Technologies*.  
<http://www.wtec.org/loyola/hdmem/toc.htm>,
- [14] Laptoplogic.com News: *Fujitsu takes Magnetic Recording Density to 1 Tb Per Square Inch*. 2007.
- [15] Matsumoto, K.; Inomata, V.A. and Hasegawa, V. S.: *Thermally Assisted Magnetic Recording*.  
FUJITSU Science Technology Journal **42**(1), 158-167, 2006,
- [16] Zhang, B.: *Development of Hard Disk Driver Promoted by Minimization*.  
Micronanoelectronic Technology **44**(3), 111-115, 2007; **44**(4), 165-169, 2007,
- [17] Yang, Y. and Zhang, B.: *On dividing development stages of human substance civilization into six ages*.  
Journal of South China University of Technology (Social Science Edition) **13**(6), 101-109, 2011,
- [18] Zhang, B. and Yang, Y.: *On the Substance of Civilization in Human Society Entering into the Nanomaterials Age*.  
Arts and Social Sciences Journal **28**, 1-12, 2011,  
[http://astonjournals.com/manuscripts/Vol2011/ASSJ-28\\_Vol2011.pdf](http://astonjournals.com/manuscripts/Vol2011/ASSJ-28_Vol2011.pdf),
- [19] Wu, Y.; Wu, X.; Qiu, Z. and Lin, S.-L.: *The history of human Development*.  
Science Press, Beijing, pp.211-214, 1978,
- [20]–: *Stone Age Summary*.  
[http://www.bookrags.com/wiki/Stone\\_Age](http://www.bookrags.com/wiki/Stone_Age),
- [21] Semaw, S. et al.: *2.6 – Million – year – old Stone Tools and Associated Bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia*.  
Journal of Human Evolution **45**, 169-177, 2003,
- [22] Gao, X.: *The first chapter in the history of mankind – The Paleolithic*.  
Fossils No. 4, 5-8, 2001,
- [23] Price, T.D.: *The Mesolithic of Western Europe*.  
Journal of World Prehistory **1**(3), 225-305, 1987,
- [24] Mellars, P.A.: *The ecological basis of social complexity in the Upper Paleolithic of southwestern France*.  
In: Price, T.D. and Brown, J.A., eds., Prehistoric hunter gatherers: The emergence of cultural complexity. Academic Press, Orlando, pp.27-97, 1985,
- [25] Day, J.V.: *Did Cavemen Play Darts?*  
<http://www.cyberdarts.com/articles/cavemandarts.html>,
- [26] Fossils Network: *Mesolithic in Europe*.  
<http://www.uua.cn/Ancient/2007/0307/4848.html>,

- [27] Mellars, P.A.: *The ecological basis of social complexity in the Upper Paleolithic of southwestern France*.  
In: Price, T.D. and Brown, J.A., eds., *Prehistoric hunter gatherers: The emergence of cultural complexity*. Academic Press, Orlando, pp.27-97, 1985,
- [28] –: *The Bronze Age*.  
[http://www.gg-art.com/copper/copper\\_index.php](http://www.gg-art.com/copper/copper_index.php),
- [29] Li, Yang; and Li, Zude: *Bloomery iron process in ancient China*.  
*Materials Science Engineering Powder Metallurgy* 4(1), 1-9, 1999,
- [30] Tewari R.: *The origins of iron-working in India: new evidence from the Central Ganga Plain and the Eastern Vindhya*.  
*Antiquity* 77(298), 536-544, 2003,
- [31] Wagner D. B.: *The earliest use of iron in China*.  
In Suzanne, M.M. et al., eds.: *Metals in antiquity*. BAR international series 792, Archaeopress, Oxford, 1-9, 1999,
- [32] Porter A. L. and Jan Y.: *Where does nanotechnology belong in the map of science?*  
*Nature Nanotechnology* 4, 534-539, 2009.
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## O MATERIJALIMA KOJI OZNAČUJU RAZVOJNA DOBĀ LJUDSKE CIVILIZACIJE

B. Zhang

Odsjek za fiziku, Sveučilište u Hunanu  
Changsha, Kina

### SAŽETAK

Temelji ljudske civilizacije razvijaju se više od tri milijuna godina, kroz kameno doba, brončano doba, željezno doba, čelično i cementno doba te silicijevo doba. Na početku ovog stoljeća, ljudsko društvo ušlo je u doba nanomaterijala, čime se u bitnome promijenio temelj ljudske civilizacije. U ovom radu razmatra se zašto tipični materijali trebaju biti jedini standard podjele ljudskog razvoja na dobā. Autor obrazlaže svoj stav o podjelama temelja ljudske civilizacije. Cilj rada je potaknuti sveobuhvatnu diskusiju o toj temi kako bi se postiglo njeno jedinstveno razumijevanje.

### KLJUČNE RIJEČI

temelj civilizacije, ljudsko društvo, uobičajeni materijali, standard podjele, proizvodni odnosi, teorija sustava tri doba, teorija sustava šest doba