

## A NOVEL PREPARATION OF CORE-SHELL STRUCTURE CARBON COPPER NANOPARTICLES

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Ultra-fine carbon coated copper nanoparticles was synthesized using plasma method. The structure, size distribution and phase composition of the particles were analysed by TEM, XRD and DSC. Meanwhile, the conductivity of carbon-coated copper nanoparticles were measured. Results show that Carbon coated copper nanoparticles were core-shell structure for the copper core inside, the multi carbon layer outside, around the copper core is graphite-like carbon and far away from the copper core is amorphous carbon. While carbon-coated copper nanoparticles at room temperature and high temperatures have shown good oxidation resistance; The conductivity of carbon-coated copper nanoparticles with metal content increases and when the copper content is 80% the conductivity jump.

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### 1. Introduction

Carbon coated nanoparticles were first found by Ruoff<sup>[1]</sup>, while the copper nanoparticles were widely used in industrial and civil areas, such as petroleum chemical production<sup>[2]</sup>, it as petroleum products hydrogenation and the most important dehydrogenation catalysts, and the production process of conductive carbon fiber nano copper catalysts also play an irreplaceable role<sup>[3]</sup>. Copper nanoparticles are being used in conductive slurry<sup>[4]</sup>, metallic and nonmetallic shows that the conductive coatings in microelectronics field play a tremendous role<sup>[5]</sup>. But because the nano copper has high surface area, decided its high chemical reaction activity, under normal temperature it reacts extremely easily with the air, water and the reaction, and loses its performance; On the other hand copper powder and organic integration of matrix is poor, extremely easy to settle, which affects performance<sup>[6,7]</sup>. Carbon bag copper nanoparticles can overcome the shortcomings of the nano copper particles, first carbon bag copper nanoparticles when they are used as catalysts, external carbon layer at normal temperature can protect copper nanoparticles from oxidation, under high temperature carbon layer is that copper oxide particles exposure<sup>[8]</sup>, can have very good

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catalytic role. Secondly when carbon bag copper nanoparticles as electronic pastes packing also has the incomparable advantage, because the outer carbon-encapsulated layer and the resin and other organic matrix has the very good fusion performance <sup>[9]</sup>, make of the preparation of electronic pastes sedimentation performance very stable. In this paper the preparation of carbon arc method innovation carbon bag copper metal nanoparticles, and the oxidation resistance and conductive properties have been studied.

## 2. Experimental

Carbon coated copper nanoparticles was produced by plasma method, graphite powders (microns) and copper powders (microns) was suppress into metal carbon composite electrode, as the anode. Graphite electrode as A cathode, reaction for argon gas protection, reaction conditions for 125 A electric arc current, voltage and V reaction and reaction chamber protective gas pressure 0.05 MPa. USES stainless steel and cooling water tank.

## 3. Results and discussion

### 2.1. XRD analysis

In figure. 1 is the XRD patterns of carbon-coated copper nanoparticles of copper content is 20% and 60% of respectively, as can be seen from the graph ,there are obvious copper diffraction peaks, corresponding copper (111), (200) and (220) face.

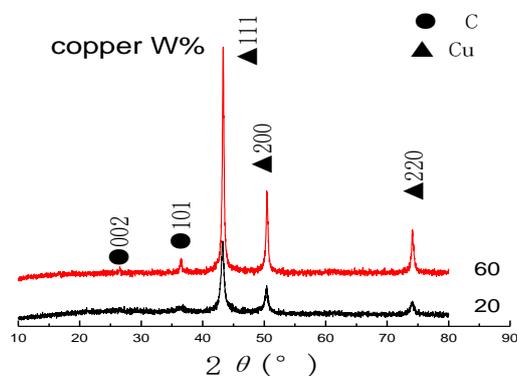


Fig.1. XRD patterns of carbon-coated copper nanoparticles.

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## 2.2. TEM analysis

In Figure 2 is the TEM micrograph of carbon-coated copper nanoparticles, from figure 2 (a) we can see that the particles are spherical size and uniform, about 20 nanometer in diameter, particle surface is smooth, and some areas have adhesion phenomenon, at the same time in the sample has certain impurity.

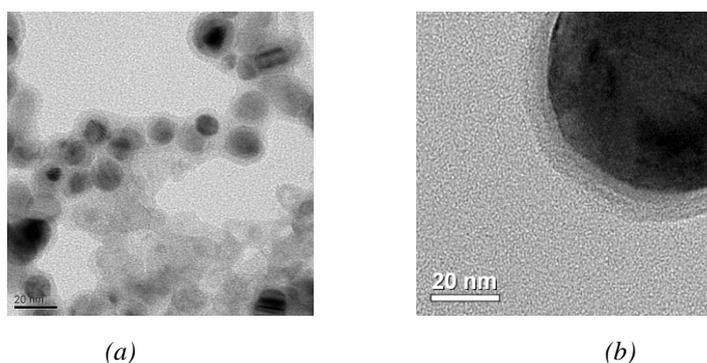
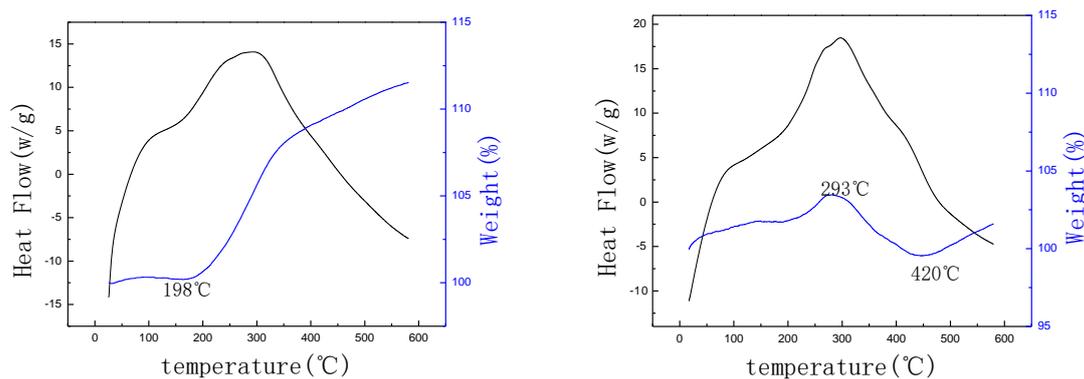


Fig. 2. (a) TEM micrograph of carbon-coated copper nanoparticles  
(b) HRTEM micrograph of carbon-coated copper nanoparticles

In figure 2 (b) of high resolution TEM pictures show carbon bag copper nanoparticles has obvious core-shell structure, outsourcing the cladding, spacing for 0.34 nm, this and XRD map of carbon in the peak of the corresponding crystal diffraction spacing is consistent, the corresponding faces is (002), is that the particles of graphite structure of carbon layer, in order to determine the composition of the impurity in the chart and type.

## 2.3. DSC-TGA analysis

Fig. 3 (a) is TGA—DSC curves of copper powder and carbon coated copper nanoparticles. figure 3 (a) is copper powders, (b) is the particles prepared in this experiment, As we can be seen from the graph copper powder and carbon nanoparticles in bag copper heating process curve shows very large weight difference, copper powder in the process of heating weight has been increased, in the process of heating the 12% increase in weight, this part of weight gain is due to the heating process copper and the oxygen in air reaction generated the copper oxide's sake. And carbon nanoparticles in bag copper heating process weight change is complex curve, room temperature to 293 °C stage, is not because of coated complete nuclear oxidation of the copper, nanoparticles appeared increase heavy phenomenon. 293 °C to 420 °C is due to the reduce weight between of carbon membrane were coated by oxidation, and when the external part of carbon membrane were oxidation of carbon dioxide gas, a part of internal copper nuclear and exposed to the air, 420 °C carbon nanoparticles after bag of copper weight gain is due to this part of the new exposure to air oxidation of copper nuclear caused. In the process of the heating carbon nanoparticles bag copper 2.5% increase in weight. From discover not hard in contrast, due to external carbon film protection, carbon nanoparticles bag copper than copper powder in the heating to show more strong antioxidant ability.



a) TGA –DSC curves of copper powder

b) TGA –DSC curves of carbon coated copper nanoparticles

Fig.3. TGA –DSC curves of copper powder and carbon coated copper nanoparticles

### 3. Conclusions

The plasma method can prepare carbon coated copper nanoparticles, nanoparticles kernel is copper particles, shell is onions like multi-walled carbon layers. The carbon layers outside have the function of protections, prevent copper core oxidized While carbon-coated copper nanoparticles at room temperature and high temperatures have shown good oxidation resistance

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