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8	刘志东 陈 勇 黄因慧 何静波 田宗军	副教授 硕士生 教 授 硕士生 副教授	052	喷射电镀Ni镀层激光重熔温度场的数值模拟	中国机械工程	2007. 18（23）
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18	王东生 田宗军 沈理达 刘志东 邱明波 黄因慧	博士生 副教授 博士生 副教授 博士生 教　授	052	钛合金表面激光重熔等离子喷涂MCrAlY涂层温度场数值模拟	应用激光	2007.27(6)
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22	赵　丹 刘志东 田宗军 黄因慧 沈理达 王东生	硕士生 副教授 副教授 教　授 博士生 博士生	052	钛合金表面激光重熔高温抗氧化涂层温度场仿真	热处理技术与装备	2007.28(6)
23	赵阳培 黄因慧 刘志东 田宗军 赵剑峰 花国然	副教授 教　授 副教授 副教授 教　授 副教授	052	脉冲射流电铸纳米晶铜的组织与性能	机械工程材料	2006.30（6）
24	李曙生 徐九华 肖　冰 严明华 傅玉灿 徐鸿钧	博士生 教　授 副教授 硕士生 教 授 教 授	052	Performance of Brazed Diamond Cup-type Wheels with Defined Grain Pattern in Grinding Cemented Carbide	南京航空航天大学学报（英文版）	2007,24(1)

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27	杨志波 徐九华 傅玉灿 徐鸿钧	博士生 教　授 教　授 教　授	052	连续扫描激光钎焊温度场有限元分析	应用激光	2007, 27(4)
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29	丁文锋 徐九华 傅玉灿 苏宏华 肖　冰	博士后 教　授 教　授 副教授 副教授	052	基于残余应力分布优选钎焊CBN磨粒出露高度	中国机械工程	2007, 18(10)
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31	丁文锋 徐九华 沈　敏 傅玉灿 肖　冰 苏宏华	博士后 教　授 硕士生 教　授 副教授 副教授	052	Development and performance of monolayer brazed CBN grinding tools	International Journal of Advanced Manufacture Technology	2007, 34
32	丁文锋 徐九华 傅玉灿 苏宏华 肖　冰	博士后 教　授 教　授 副教授 副教授	052	Effects of the Embedding Depth on the Residual Stresses in the Brazed Cubic Boron Nitride Abrasive Grain	The International Symposium on Advanced Abrasive Technology会议论文集	美国 Dearborn, 2007年9月
33	卢金斌 徐九华	博士生 教　授	052	真空钎焊金刚石界面碳化物的形貌	中国有色金属学报	2007, 17(7)
34	徐九华 丁文锋 傅玉灿	教　授 博士后 教　授	052	Fabrication and Characterization of Brazed CBN Wheels with Rhythmed Grain Distribution	The International Symposium on Advanced Abrasive Technology会议论文集	美国 Dearborn, 2007年9月
35	葛英飞 徐九华 杨　辉 罗松保 傅玉灿	博士生 教　授 教　授	052	碳化硅增强颗粒含量和尺寸对铝基复合材料超精密车削表面的影响	机械工程材料	2007, 31(6)
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37	葛英飞 傅玉灿 徐九华	博士生 教 授 教 授	052	Experimental Study on High Speed Milling of γ -TiAl Alloy	Key Engineering Materials	2007, 339
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39	赵建社 徐家文 王福元	讲 师 教 授 副教授	052	整体构件数控电解加工数字化仿真技术	南京航空航天大学学报	2007,39(3)
40	赵建社 徐家文 朱永伟	讲 师 教 授 副教授	052	Design Optimization of Cathode's Feeding Path of NC-Electrochemical Machining Based on Computer Simulation of Shaping Process	Proceedings of the 15th International Symposium on Electromachining	2007,4
41	张伟 徐家文	硕士 教授	052	铝合金薄壁整体的数控电解加工试验研究	电加工与模具	2007, 4
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45	朱永伟 徐 锋 沈建良	教 授 讲 师 硕士生	052	Study on the Modification of Nanodiamond with DN-10	Journal of Material Science and Technology	2007,23(5)
46	沈建良 朱永伟	硕士生 教 授	052	固结磨料抛光垫作用下的材料去除速率模型	中国科技论文在线	2007年4月17日
47	钟磊 卢文壮 王鸿翔 徐锋 左敦稳	硕士 副教授 博士生 讲师 教授	052	小型化金刚石膜沉积设备控制系统研究	硅酸盐通报	2007, 26(6)
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53	汪通悦 何　宁 李　亮	博士生 教授 副教授	052	薄壁件铣削加工的振动模型	机械工程学报	2007,43(8)
54	汪通悦 何　宁 李　亮	博士生 教授 副教授	052	VIBRATION IN HIGH-SPEED MILLING OF THIN-WALLED COMPONENTS	Transactions of Nanjing University of Aeronautics & Astronautics	2007,24(2)
55	杨岭飞 李　亮 何　宁	博士生 副教授 教授	052	一种新的刀具磨损面图像边界提取方法	南京航空航天大学学报	2007,39(6)
56	李多生 左敦稳 陈荣发 相炳坤 赵礼刚	博士生 教　授 副教授 讲　师 学　生	052	大尺寸金刚石膜生长中等离子体弧源的稳定性	南京航空航天大学学报	2007, 9(3)
57	李多生 左敦稳 陈荣发 相炳坤 赵礼刚 王　珉	博士生 教　授 副教授 讲　师 学　生 教　授	052	直流等离子体CVD金刚石薄膜微观结构分析	稀存金属材料与工程	2007, 36(4)
58	李多生 左敦稳 周贤良 华小珍 陈荣发 赵礼刚	博士生 教　授 教　授 教　授 副教授 学　生	052	Microdistortion behavior of Al alloy reinforced by sicp	Trans. Nonferrons Met. Soc. China	2007, 133(17)
59	徐　锋 左敦稳 卢文壮 王　珉	讲　师 教　授 副教授 教　授	052	Effect of Grid Bias on Deposition of Nanocrystalline Diamond films	TRANSATION of NUAA	2007, 24(4)
60	徐　锋 左敦稳	讲　师 教　授	052	关于机械制造技术课程改革的探索与实践	高校教育管理	2007, 1(4)
61	徐　锋 左敦稳 卢文壮 李　磊 王　珉	讲　师 教　授 硕士生 教　授	052	HFCVD 衬底三维温度场有限元模型	机械工程学报	2007, 43(6)
62	李　磊 左敦稳 徐　锋 黎向锋 卢文壮	硕士生 教　授 讲　师 副教授 副教授	052	HFCVD 系统中衬底接触热阻的研究	人工晶体学报	2007, 36(1)
63	张海余 左敦稳 徐　锋 闫　静	硕士生 教　授 讲　师 副教授	052	基于ANSYS的HFCVD金刚石厚膜的热应力分析	人工晶体学报	2007, 36(1)
64	左敦稳 Kawano Yoshihire	教　授	052	Application projection image of end mill to monitor its behaviour	Int. J. Computer Applications in Technology	2007, 28(1)
65	郭　魂 左敦稳 唐国兴	教　授	052	面向应用的“机电系统控制技术”课程本科教学改革初探	装备制造技术	2007, (10)
66	于守鑫 孙玉利 左敦稳	硕士生 博士生 教　授	052	不同温度下单晶硅硬度的测试分析	扬州大学学报	2007, 1

67	于守鑫 左敦稳 卢文壮	硕上生 教　授 副教授	052	硬质合金上镀铜	电镀与涂饰	2007, 26(1)
68	陈荣发 左敦稳 徐　锋 李多生 王　珉	博士生 教　授 讲　师 博士生 教　授	052	Diamond Film Synthesis with a DC Plasma Jet: Effect of the Contacting Interface between Substrate and Base on the substrate Temperature	J. Mater. Sci. Technol	2007, 23(4)
69	陈荣发 左敦稳 孙玉利 卢文壮 李多生 王　珉	副教授 教　授 博士生 副教授 博士生 教　授	052	Investigation on the Machining of Thick Diamond Films by EDM Together with Mechanical Polishing	Advanced Materials Research	2007, 24-25
70	孙玉利 左敦稳 朱永伟 徐　锋 王　珉	博士生 教　授 教　授 讲　师 教　授	052	连续刚度法对单晶硅片的力学性能的表征	硅酸盐学报	2007, 35(11)
71	孙玉利 左敦稳 朱永伟 王　珉	博士生 教　授 教　授 教　授	052	Surface Formation of Single Silicon Wafer Polished with Nano-sized Al2o3 Powders	CHINSE JOURNAL OF CHEMICAL PHYSICS	2007, 20(6)
72	孙玉利 左敦稳 朱永伟 陈荣发 李多生 王　珉	博士生 教　授 教　授 副教授 讲　师 教　授	052	Experimental study on Cryogenic Polishing Single Silicon Wafer with Nano-sized Cerium Dioxide Powders	Advanced Materials Research	2007,24-25
73	孙玉利 左敦稳 朱永伟 徐　锋 王　珉	博士生 教　授 教　授 讲　师 教　授	052	CHARACTRIZATION OF SURFACE LAYER OF SILICON WAFER BY USING NANO INDENTER	Proceodings of the International conference on Intergration and Commercialization of MNC 2007	2007
74	谢清华 谷　安 王梦珂	硕士生 讲　师 硕士生	052	基于新型触须传感器的外形检测	自动化仪表	2007,02
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77	谢清华 谷　安 但春华	硕士生 讲　师 硕士生	052	基于PSD的机器人触须传感器系统	机电一体化	2007,02
78	谷　安 谢清华	讲　师 硕士生	052	机器人触须传感器动态工作机理的研究	传感器与微系统	2007,05
79	谷　安 谢清华	讲　师 硕士生	052	机器人触须传感器工作机理的研究	仪器仪表学报	2007,S1
80	章　勇 谷　安 项甫根	硕士生 讲　师 硕士生	052	基于DXF文件的低速走丝线切割加工自动编程系统的开发	电加工与模具	2007,05

81	朱 荻 王 昆 曲宁松	教 授 博士生 副教授	052	Micro Wire Electrochemical Cutting by Using In Situ Fabricated Wire Electrode	CIRP Annals - Manufacturing Technology	2007,56(1)
82	朱增伟 朱 荻 曲宁松 雷卫宁	博士生 教 授 副教授 教 授	052	Electrodeposition of bright nickel coating under perturbation of hard particles	Materials & Design.	2007, 28(6)
83	张朝阳 朱 荻 曲宁松 王明环	博士生 教 授 副教授 博士生	052	Theoretical and Experimental Investigation on Electrochemical micro-machining	Microsystem Technologies.	2007, 13(7)
84	张朝阳 朱 荻 曲宁松 王 昆	博士生 教 授 副教授 博士生	052	Electrochemical Machining of Micro-structures With Nanosecond Pulses	Proceedings of the International Conference on Integration and Commercialization of Micro and Nanosystems .	MNC2007
85	张朝阳 朱 荻 王明环	博士生 教 授 博士生	052	纳秒脉冲微细电化学加工的理论及试验研究	机械工程学报	2007, 43(1)
86	张朝阳 朱 荻 曲宁松 王明环	博士生 教 授 副教授 博士生	052	微米级电化学加工关键技术研究	中国机械工程	2007, 18(4)
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89	徐正扬 朱 荻 史先传	博士生 教 授 博士后	052	基于Labview/Flexmotion电解加工机床控制系统软件的设计	. 计算机与应用化学	2007, 24(4)
90	徐正扬 朱 荻 王 蕾 史先传	博士生 教 授 博士生 博士后	052	叶片电解加工三头柔性进给放心优化设计	中国机械工程	2007, 18(24)
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92	曾永彬 朱 荻 曲宁松	博士生 教 授 副教授	052	Fundamental research on micro electroforming of metal microstructures by using shielded anode	Proceedings of the International Conference on Integration and Commercialization of Micro and Nanosystems	MNC2007
93	曾永彬 朱 荻 曲宁松	博士生 教 授 副教授	052	屏蔽模板随动式微细电铸技术	第12届全国特种加工学术会议	2007, 28(17)
94	王 昆 朱 荻 曲宁松	博士生 教 授 副教授	052	Investigation on Wire Electrochemical Micro Machining	Proceedings of the International Conference on Integration and Commercialization of Micro and Nanosystems	MNC2007
95	王 昆 朱 荻 张朝阳	博士生 教 授 博士生	052	微细电解线切割加工的基础研究	中国机械工程	2007, 18(7)

96	王 昆 朱 荻 张朝阳	博士生 教 授 博士生	052	微细电解线切割加工控制系统	机械科学与技术	2007, 26(7)
97	王 昆 朱 荻 曲宁松 王少华	博士生 教 授 副教授 博士生	052	微细电解线切割加工的模型分析与试验研究	特种加工年会会议论文	2007
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99	郑晓虎 朱 荻 朱增伟	博士生 教 授 博士生	052	微机电系统用电铸镍铁合金的制备及其电磁性能	.机械工程材料	2007, 33(3)
100	胡洋洋 朱 荻 曾永彬 明平美	博士生 教 授 博士生 博士后	052	UV-LIGA制作微细群电极工艺研究	.2007年中国机械工程学会年会论文集	2007
101	张美丽 朱 荻 徐正扬	硕士生 教 授 博士生	052	基于ANSYS分析的钛合金电解辅助阳极设计	.机械科学与技术	2007, 26(9)
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103	张美丽 朱 荻 徐正扬	硕士生 教 授 博士生	052	钛合金TC4电化学加工均匀设计试验研究	电化学	2007, 13(1)
104	王 磊 朱 荻 曲宁松 王明环	硕士生 教 授 副教授 博士生	052	电化学腐蚀法制备微细群圆柱	机械科学与技术.	2007, 26(7)
105	王 磊 朱 荻 曲宁松 王明环	硕士生 教 授 副教授 博士生	052	微细群孔电解加工试验研究	微细加工技术	2007, 2
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108	王光强 朱 荻 曲宁松	硕士生 教 授 副教授	052	蜂窝状微坑结构的电化学加工研究	电加工与模具	2007, 2
109	韩 峰 朱 荻 曲宁松	硕士生 教 授 副教授	052	整体叶轮电火花加工电极的成形电铸	.电加工与模具	2007, 1
110	邱 勇 曲宁松 李寒松 钱双庆	硕士生 副教授 讲 师 博士生	052	摩擦副表面微小阵列微坑电解加工技术研究	南京航空航天大学第九届研究生学术会议	2007
111	刘 燕 曲宁松 王 维	硕士生 副教授 博士生	052	深小孔电解加工工艺研究	南京航空航天大学第九届研究生学术会议	2007

112	薛　宝 曲宁松 李寒松 陈建明	硕士生 副教授 讲　师 技　师	052	摩擦副表面微坑结构的微细电解加工技术研究	南京航空航天大学第九届研究生学术会议	2007
113	孟　轶 曲宁松	硕士生 副教授	052	分层电铸加工装置的开发	南京航空航天大学第九届研究生学术会议	2007
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115	郭紫贵 云乃彰 张　磊	硕士生 教　授 硕士生	052	数控展成电解加工带冠整体叶轮的运动规划及其实现	电加工与模具	2007(5)
116	郭紫贵 云乃彰 张　磊	硕士生 教　授 硕士生	052	带冠整体叶轮叶片型面组合电加工工艺研究	第12届全国特种加工学术会议	2007
117	李红英 云乃彰 汪建春 朱永伟	硕士生 教　授 硕士生 博士后	052	超声电解同步复合微细加工中微位移的实现与检测	第12届全国特种加工学术会议	2007
118	李红英 云乃彰 朱永伟	硕士生 教　授 博士后	052	微细槽超声电解复合微细加工的实验研究	第12届全国特种加工学术会议	2007
119	毛计庆 云乃彰 孟　轶 曲宁松	硕士生 教　授 硕士生 副教授	052	基于EFAB的金属微细三维结构电铸技术及 机床设计	第12届全国特种加工学术会议	2007
120	杨志伟 云乃彰 陈建宁	硕士生 教　授 技　师	052	微凸起及微坑结构的放电加工基础性研究	微细加工技术	预定2007刊出

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JET EIECTRDEPOSITED Cu-Al_2O_3 NANOCOMPOSITE COATINGS

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ABSTRACT

A jet electrodeposition device was carried out to prepare Cu-Al_2O_3 nanocomposite coatings. The influence of the concentration of Al_2O_3 in the electrolyte and parameters, such as cathodic current density, the electrolyte temperature as well as the electrolyte jet velocity, on the content of the Al_2O_3 in the deposite were investigated. The coatings ingredient and microstructure was measured by the scanning electron microscope(SEM) with energy dispersive analyzer system (EDX), the microhardness tests were conducted on an microhardness tester. The results show that the jet electrodeposition can fine crystalline particles. The copper deposited layers have nanocrystalline microstructure with grain size of about 50nm . The amount of Al_2O_3 in composites first increased and then decreased with an increase in the concentration of Al_2O_3, current density, temperature and jet velocity. The composite with optimum atomic percent of Al_2O_3 (14.4 at%) can be obtained at the concentration of 30 g/l , cathodic current densities 300 A/dm^2, temperature 30℃, and electrolyte jet velocity 8 m/s . The addition of Al_2O_3 in copper increases the microhardness of the electrodeposited coatings.

Keywords: jet , electrodeposition, , nanocrystalline, current density， grain size，nanocomposite coatings

1.INTRODUCTION

Metal-matrix nanocomposites are materials in which the properties of a metallic host material are modified with the addition of a second phase . Electrodeposition of nanocomposite coatings, based on second phase hard particles dispersed in a metallic matrix, is gaining importance for potential engineering applications. The second phase can be hard oxide (Al_2O_3, TiO_2, SiO_2) or carbides particles (SiC, WC). However, the very low depositing rate of the conventional electrodeposition has limited the practical application of electrodeposition as a mean to prepare the composite materials. Then, the jet electrodeposition as a new technique with the special flow characteristics, has been used for local coating reaction on an unmasked cathode. During the jet electrodeposition process, the electrolyte is jetted on a cathode surface directly because of the existence of electric field between the cathode and anode located in the jet nozzle, as the electric current travels along the jet stream to the cathode, the deposition takes place only on the local cathode surface area where the jet impinges on. thus, jet electrodeposition possesses high depositing rate. In addition, the grain size refining effect of jet electrodeposition is more efficient because a much higher overpotential of cathodic substrate can be used with much higher current density. the articles reported that the deposit layer have crystalline microstructure .

2. EXPERIMENT

2-1. Experimental principle

The schematic representation of the equipment and measurement circuit of jet electrolyte conducted in the cell are shown in Fig. 1. The electrolyte was pumped from the vessel with invariable temperature electrolyte, and then reflowed to the vessel from the output of electrodeposting room via the bump of filter, and the flowmeter. The electrolyte temperature was measured by the heater and temperature transducer. the jet velocity was adjusted by control valve.

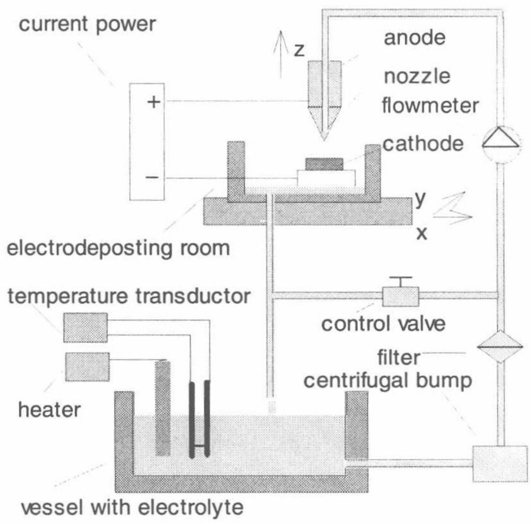


Fig.1. Diagram of measurement circuit applied for jet electrodeposition .

2-2. Electrolyte ingredient and experimental parameters

A initially device was designed for the fabrication of composite coatings. A electrolyte was used to deposition on the flat stainless steel substrate under the following condition:

electrolyte:	Cu_2SO_4¡¤5_2O (250 g/l); H_2SO_4 (50 g/l)
concentration of Al_2O_3(50 nm):	10-40 g/l
current densities:	200-500 A/dm^2
jet velocity:	4 -10 m/s
temperature:	20-40 ℃
pH:	4.0

2-3. Composition analysis

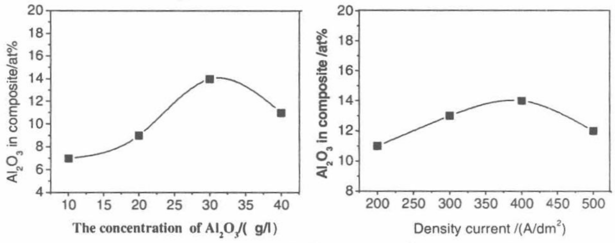
The composites ingredient and microstructure was measured by using a field emission scanning electron microscope with energy dispersive analyzer system (EDX), The SEM samples were vibrated by ultrasonic vibrator and washed in distilled water and alcohol. Vickers microhardness tests were conducted on an HXS-1000A microhardness tester using a load of 50 g, applied for 10 s. Each hardness value was an average of five measurements.

3. RESULTS

3-1. Effect of concentrations and current density

The incorporation of Al_2O_3 in the copper deposit with different contents (10–40 g/L) of Al_2O_3 particles suspended in the electrolyte at current densities 300 A/dm^2, 30 ℃ and jet velocity 8 m/s , pH 4.0 is shown in Fig. 2(a). According to the data obtained, the at% of Al_2O_3 in the deposit increases sharply with increasing the concentration of Al_2O_3 in the electrolyte and attains the optimum values at 14.4 at% at30 g/l Al_2O_3 suspension in the bath. With further additions, the amount of Al_2O_3 slightly decreases. These phenomena play an especially considerable role in particle codeposition with copper, due to the high adsorption affinity of copper for the solid particles. The data obtained in this investigation can be explained in terms of adsorption of Al_2O_3 on the cathode surface. With increased amount of Al_2O_3 in the electrolyte copper will be deposited with a higher amount of Al_2O_3 and a large area of the cathode surface covered. The optimum value of Al_2O_3 (14.4 at%) means that the all surface area of the cathode is approximately covered with Al_2O_3 and copper ions.

The current density on the cathode surface is a measure of the volume of Al_2O_3 in the deposit. The effect of current density on the at% of the Al_2O_3 incorporation in the deposits at 30 g/l Al_2O_3, pH 4.0, 30 ℃. particles in the bath is shown in Fig. 2(b). It was found that, the at% of Al_2O_3 increases with increasing current densities and maximum incorporation (14.0 at%) could be achieved at 400 A/dm^2. With further increase in the current densities than 400 A/dm^2, the extent of codeposition of Al_2O_3 decreases to 12.0 at% at 500 A/dm^2. As the current density increases the solution in the vicinity of the cathode tends to become depleted of metallic ions and polarization increases and codeposition rate increases, the content of Al_2O_3 adsorbed on the cathode increases. The maximum current density is reached when the rate of movement of metallic ions and Al_2O_3 particles from the bulk solution to the cathode surface is equal to the rate of deposition. At current density above 500 A/dm^2, the metal is being deposited under conditions of charge transfer overpotential control. As a result, the reduction of copper ions is controlled by concentration overpotential, the amount of codeposition of Al_2O_3 particles gradually decreases.



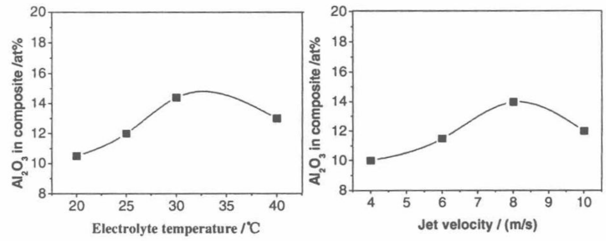
(a) the concentration of Al_2O_3 (b) current density

Fig. 2 The at% of Al_2O_3 in composite.

3-2. Effect of elecrolyte temperature and jet velocity

The influence of electrolyte temperature(20-40℃) on Al_2O_3 incorporation at 30 g/l Al_2O_3, current densities 300 A/dm^2 ,jet velocity 8 m/s, and pH 4.0 is shown in Fig. 3(a). It is clear that the temperature of the solution noticeably influences the amount of Al_2O_3 in deposit. The result indicates that Al_2O_3 incorporation increases from 11.2 at% at 20 ℃ to 14.4 at.% at 30 ℃ With further increase of the temperature, a decreasing trend is observed, resulting from decrease in the current efficiency of the bath. The electrolyte jet velocity also plays an important role in the electrodeposit process for the transportation of Al_2O_3 particles to the cathode for the codeposition. Fig.3(b). shows the effect of jet velocity on the at% of Al_2O_3 in the composite at pH 4.0, 30 ℃, current densities 300 A/dm^2, and 30 g/l Al_2O_3 in the electrolyte. It is seen that the amount of Al_2O_3 in the composite increases with increasing jet velocity up to 8 m/s. The highest at% of Al_2O_3 in the composite is obtained at 8 m/s. The at% of Al_2O_3 in the composite decreases beyond 8 m/s.

Increasing the jet velocity of the electrolyte flow in jet deposition is equivalent to increasing the stirring intention of the electrolyte. This results in the reduction of the diffusion layer thickness and it is accompanied by the increasing of the metallic ion concentration in the diffusion layer. The Al_2O_3 particles concentration in the diffusion layer is therefore increased, Hence, the increasing of jet velocity results in the increase of Al_2O_3 content in the deposit. under high jet velocity, the Al_2O_3 particles absorbed on the cathode are partly taken away, which resulted in a decreased amount of the Al_2O_3 codeposition

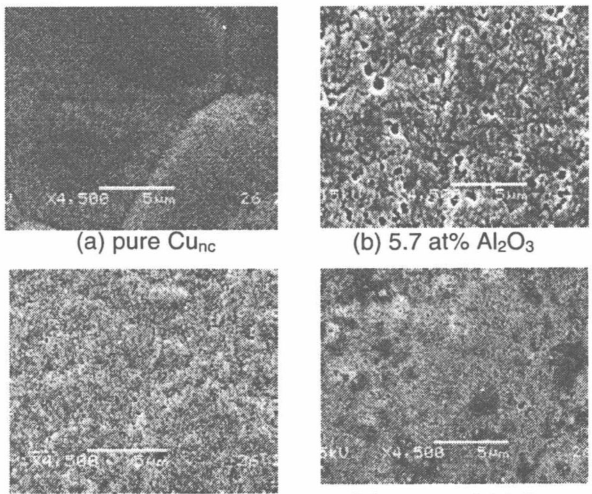


(a) electrolyte temperature (b) jet velocity

Fig. 3 The at% of Al_2O_3 in composite.

3-3 Surface microstructure analysis

The SEM surface morphologies of electrodeposited pure Cu and Cu-Al_2O_3 nanocomposites is represented in Fig. 4. It shows that there is the formation of finer grains in the deposited layer. It seems as compact and smooth.



(a) pure Cu_{nc} (b) 5.7 at% Al_2O_3

(c) 9.7 at % Al_2O_3 (d) 14.4 at% Al_2O_3

Fig .4 SEM surface micrographs of the copper

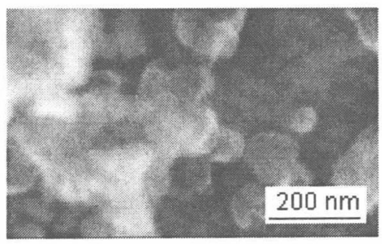


Fig. 5 SEM image of deposited layer.

Fig.5 is a high magnified view of Fig.6(d), displaying the typical nanostructure of copper electrodeposite layer, it clear see that average grain size is various from 50nm to 60nm evaluating by the staff in SEM graph.

3-4 Microhardness

The microhardness of materials depends upon many factors and the most important factor is the composition of the electrodepositing bath. The relation between the incorporation of Al_2O_3 in deposit and microhardness is shown in Table 1.

Tab.1 Microhardness of Cu_{nc}-Al_2O_3 composite coatings

Example	Microhardness/GPa
Crude Cu	0.2
pure Cu_{nc}	1.2
Cu_{nc}/Al_2O_3(5.7 at%)	1.7
Cu_{nc}/Al_2O_3(9.0 at%)	1.9
Cu_{nc}/Al_2O_3(14.4 at%)	2.1

The results indicate that the pure Cu_{nc} provide the far higher microhardness than crude Cu, it is up to 1.2 Gpa , about 6 time as high as the latter, additional , the incorporation of Al_2O_3 particles with copper also gives much higher values . The hardness increases with increasing of the Al_2O_3 particles in the deposit. The higher hardness is produced due to the dispersion hardening effect of the Al_2O_3 particles and also as a result of the fine-grained structure of the composites. During microhardness measurements, the dispersed particles in the fine-grained matrix may obstruct the easy movement of dislocations and resist plastic flow. This resistance to deformation is shown by an increasing hardness value for Cu-Al_2O_3 composite.

4. CONCLUSIONS

The results of this investigation suggest some general conclusions, which can be summarized as follows.

1. The electrodepsited layer grain size was greatly finned because of supply of much more current density nanostructured composites were obtained through jet electrodeposition.

2. The amount of Al_2O_3 in composites first increased and the decreased with an increase in the concentration of Al_2O_3, cathodic current density, eletrolyte temperature and jet velocity. The composite with maximum value (14.4 at%) can be obtained at the concentration of 30 g/l current densities 300 A/dm^2,electrolyte temperature 30 ℃,and jet velocity 8 m/s.

3. The microhardness of the composites increases gradually in the direction of the growth of the deposit. The top hardness is high up to 2.1Gpa.

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REFERENCES

[1] K.H. Hou., and M.D. Ger., 2002, "The wear behaviour of electrocodeposited Ni–SiC composites" , Journal of Applied Elect rochemistry, 32(4), pp.12

[2] M.Ghorbani., M.Mazaheri ., and K.Khangholi., 2001, "Electrodepostion of graphite-brass composite coatings and characterization of the tribological properties" . Surf Coat Tech , 148(5), pp.71

[3] M. Surender., and B. Basu ., 2004, "Wear characterization of electrodeposited Ni-WC composite coatings". Tribology International , 37(6), pp.749

[4] B.S.Xu., and H.D.Wang., 2005, "Electrodepositing nickel nanocomposites coatings", Electrochemistry Communications, (7), pp.572

[5] M. Stroumbouli., and P. Gyftou., 2004, "Codeposition of WC in Ni matrix composite electrocoatings", Surf Coat Tech, 195(3), pp.325

[6] H.Z.Wang., 2004, Electrochemical preparation and characterization of Ni/SiC gradient deposit" . Journal of Materials Processing Technology, 145(5), 299

[7] G.Y. Qiao., 2005, "High-speed jet electrodeposition and microstructure of Ni–Co alloys", Electrochimical Acta, 12(4), pp.200

[8] J.S. Chen., Y.H. Huang., and Z.H. Liu., 2005, "Jet electrodeposition oriented by rapid prototyping", Trans Nonferrous Met.Soc.Chna, 15(S3), pp.247

[9] Y.Xiong., and T.F.Jing., 2002, "A study of jet electrodeposting nanocrystalline Nickle", Plating and Finishing, 22(5), pp.4

[10] Y.J.Xue., D.Zhu., and F.Zhao., 2004, "mechanical properties of Ni-La_2O_3 nanocomposites",Journal of Materials sciences , 39(7), pp.4063

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A STUDY ON THE ELECTRODEPOSITED CU- AL_2O_3 COMPOSITES COATING WITH LASER TREATMENT

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ABSTRACT

One kind of jet electrodeposition machine with multi-spindle function has been successfully designed and launched. With the jet electro-deposition device, Al_2O_3 particles of average size 30 nm were co-deposited with Copper on a steel substrate using a Watts bath at 50℃ and the compound layer was processed by laser in order to make the layer clad on the substrate in a well binding force. The compound layer's microstructure was examined by scanning electron microscopy (SEM), the mechanical properties of the coated steels were examined with hardness and tensile tests. The effects exerted by the current density, weight percentage of Al_2O_3 in electrolyte and the presence of laser treatment was investigated respectively .It shows a relatively small current density and a certain of Al_2O_3 particles have a positive effect on both surface morphology and coated material 's mechanical behavior .In addition, result also shows the coating processed by laser, attained a hardness up to 820 HV, which is considerably increased than substrate.
Keywords: electrodeposition; copper; nanosized Al_2O_3; laser; Mechanical properties;

1. INTRODUCTION

30CrMnSiA is a kind of high strength structural steel, which has been found well suited for applications on aircraft and aerospace vehicles manufacturing. To improve wear performance and strength, as well as other surface properties such as oxidation and corrosion, these materials are generally surface coated and the resulting coatings are expected to achieve a particular property. Nowadays, many surface techniques have been applied to improve the surface properties of metals. Among them, electro methods are considered as the comparatively economical ways involved in surface modification [1]. Electrodeposition of composite coatings, based on hard particles dispersed in a metallic matrix, is attracting much interest in recent years.

The second phase in composite particles can be hard oxide (Al_2O_3, TiO_2, SiO_2), carbides particles (SiC, WC), diamond, solid lubricate (PTFE, graphite, MoS_2), and even liquid containing microcapsules [2].

However, due to the limit of electro chemistry mechanism, the mechanical bond of deposit layer and substrate tends to break away and shell under adequate force outside. As a potential solution, the present work was undertaken, by conducting the intensification of laser surface with deposit coating. A new method called jet electrodeposit was used to deposit a Copper-nanoAl_2O_3 layer and another procedure of laser scanning on compound layer follows last one to melt the layer to turn mechanical bond between deposit layer and matrix into a metallurgical bond, thereby strengthening the binding force and enhancing the characteristics of the material [1][2].

The compound layer was examined by microhardness measurements, stretch test and scanning electron microscopy (SEM) in this work.

2. EXPERIMENTAL DEVICE AND PARAMETER SET

The Jet electrodeposition system is composed of CNC unit and electrolyte circulation unit. CNC unit includes industrial PC, software and servo system, in charge of the desired movements of nozzle. Electrolyte circulation unit was responsible for the management of electrochemistry parameters including voltage, current, and temperature.

The schematic representation of the equipment and measurement circuit of jet electroplating is shown in Fig 1.The apparatus fundamentally consists of a electrodepositing section, a set of circulation system and stirrer.

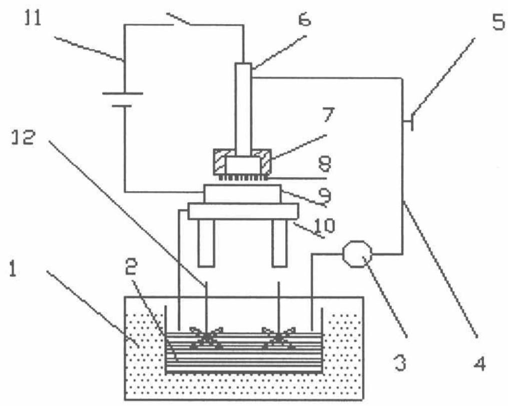


Fig.1. Schematic diagram of circuit applied for jet electrodeposition. (1) normal temperature water bath for electrolyte; (2) electrolyte; (3) pump; (4) PVC pipe; (5) electrolyte valve; (6) Cu anode; (7) nozzle; (8) electrolyte stream; (9) substrate (cathode); (10) worktable; (11)power supply and current circuit; (12) churn-dasher

Table 1. Composition of the electrolytic

ElectrolyteMaterial	Amount(g/L)
$CuSO_4 \cdot 5H_2O$	250
Surfuric. acid	50
Dodecyl sodium sulphate	0.1

3.EXPERIMENTAL PROCEDURE

To provide uniform surface activity, prior to electrodeposition, cleaning and conditioning treatments were necessary to be performed on 30CrMnSiA with the following steps. Initially, the substrate was polished with diamond abrasive to obtain an extreme smooth surface and degreased with acetone to remove oil and grease. Further more, 30CrMnSiA should be fully immerged in 15% nitric acid for 20 minutes to clear away rust and other contamination [3].

After cleaning, specimens were immediately taken on the electrolytic worktable as a cathode. The electrolyte's temperature was kept around 50 °C through the whole experiment and the composition of electrolyte was given in Table 1. In procedure, nozzle, controlled by CNC, continued scanning backwards and forwards alone the worktable with a constant distance of 1 mm between anode (nozzle) and cathode (substrate). For an optimal deposition, the cathode current was precisely set in a range of 0.01 to 0.1 A. All the electrodeposition experiments were carried out in the bath for 1 h with constant stirring by a magnetic stirrer so that all the Al_2O_3 particles could be sufficiently wetted and remained suspended uniformly in the electrolyte.

One 2 kW transverse-flow CO_2 laser made by Prima Laser Machinery Company, was used to melt the electrodeposited compound layer together with 30CrMnSiA substrate. Laser process was performed with optimized parameters, including laser power of 1 KW, scan speed of 1 m per min, a constant beam diameter of 3 mm. Fig 2 illustrates the process.

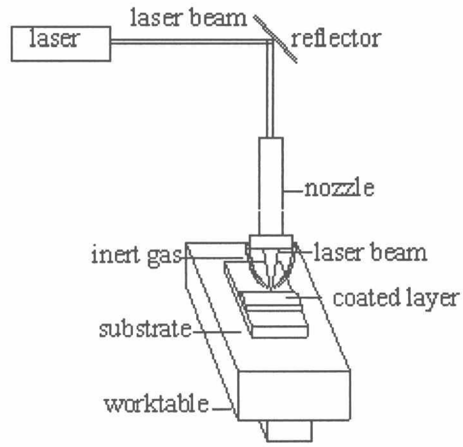
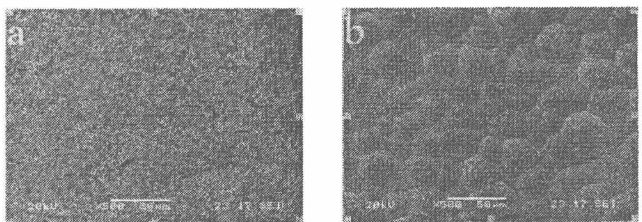


Fig. 2. Diagram of laser processing on the compound deposition layer

4. RESULTS AND DISCUSSION

4-1. Effects from nanosized Al_2O_3 on surface morphology of deposition layer

Fig 3 shows surface morphology, which was respectively obtained under different current density. From SEM, we can find under a condition of low current density, a flat coating surface on which the grain size seems obviously decreased can be obtained. With the current increasing, coating surface begins with a transition to growth morphology of cystiform grain. On the contrary, when the current was set relatively high, a dramatically growth of cystiform grain occurred and as a response, a tendency of deposit layer deteriorating off compactness and flatness appeared in the end.



(a) 150 A/dm^2 (b) 300 A/dm^2

Fig.3. SEM photographs of Cu-Al_2O_3 layer with relatively low current density