



Antibacterial Stainless Steel

China Shenyang Rongrong Science & Technology Co Ltd is a high-tech enterprise specialized in the structural/functional metallic materials dedicated to R&D and applications of biomedical metal materials

Since its creation, Rongrong has developed many novel structural/functional materials and products with independent intellectual property rights, including "INCO" series super austenitic antibacterial stainless steel, antibacterial titanium alloys, biodegradable magnesium alloy and high strength and high toughness maraging steel like integrated structural/functional materials. These novel bio-functional materials have broad application prospects in civil, medical, aerospace, and many other fields.

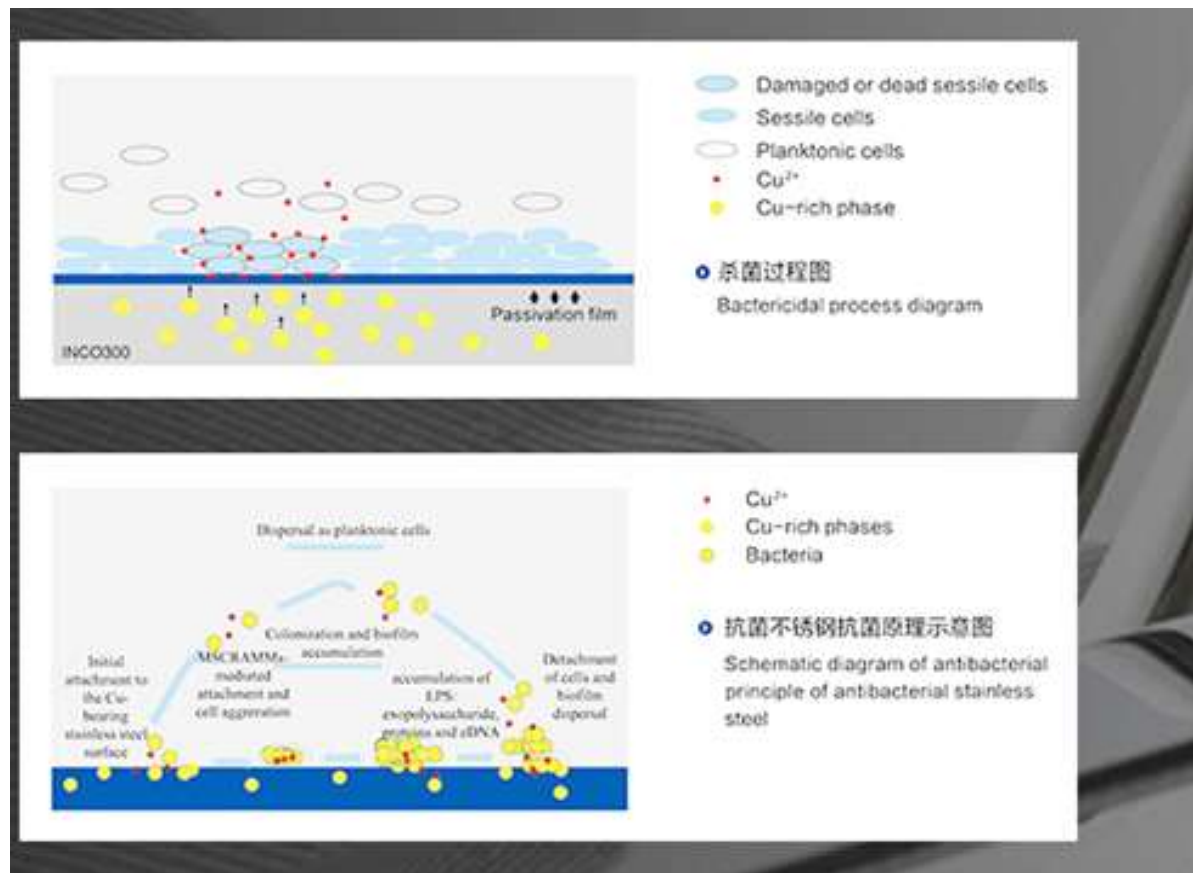
At present, Rongrong has about 20 members research team, including 13 PhDs and 6 master's degree holders. By establishing a joint R&D laboratory an implementing resource sharing and open project system, Ronrong has attracted many experts and scholars from Institute of Metal Research, CAS, China Medical University, Northeastern University like renowned institutions for research collaborations. Rongrong has applied for 10 national invention patents and been successfully granted 9 of them, also 6 utility model patents have been authorized, while 12 SCI indexed papers have been published in the well-known international journals. In addition, Rongrong has been recognized by the China Health Industry Association and is a member of antibacterial association since 2017.

Rongrong adheres to "People oriented, honesty and innovative Future" concept, committed to realize the goal of ubiquitous antibacterial products green living in future, aspiring to become a subverter of traditional metal materials and a guide for structural/functional metal materials.

Antibacterial Principle

Bactericidal process diagram

Schematic diagram of antibacterial principle of antibacterial stainless steel



Taking into account the antibacterial property, safety, mechanical and corrosion resistance property, Copper (Cu) as the main antibacterial element, was dissolved into the stainless steel matrix through special smelting process which was then precipitated out of supersaturated matrix using specific heat treatment process as Cu-rich phase. When copper bearing stainless steel contacts with moist air or corrosive medium, the uniformly distributed copper rich phase releases copper ions to induce excellent antibacterial effect. The copper ions can effectively inhibit the formation of bacterial biofilm by destroying the bacterial cell membrane, cell walls and their enzyme systems to prevent bacterial infection.

Copper is a necessary trace element for normal physiological activities of human body.



铜在心血管系统中的有益作用：

微量铜离子的持续释放能够促进内皮细胞的增值和迁移，增加内皮细胞中VEGF等因子的表达，进而加速伤口的愈合。同时，铜离子还能抑制平滑肌细胞的活性，降低血栓的形成倾向，在维护心血管的健康方面起着重要的作用。

——参考文献：现代生物医学进展 《铜在心血管系统中的有益作用》

铜是人体所必需的韧骨元素：

2001年美国FNB指出，铜是酶促反应的辅助因子。特别是，胶原蛋白形成必需的赖氨酰氧化酶含铜，而胶原蛋白是骨组织的重要组成部分。铜缺乏可抑制骨骼生长和导致骨质疏松。

——参考文献：FOOD AND NUTRITION BOARD, INSTITUTE OF MEDICINE. (Dietary Reference Intakes for VitaminA, VitaminK, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc[M].

The beneficial effects of copper in the cardiovascular system:

The continuous release of trace copper ions can promote the increment and migration of endothelial cells as well as increase the expression of VEGF like factors in endothelial cells to accelerate the healing of the wounds. At the same time, copper can also inhibit the activity of smooth muscle cells, reduce the tendency of thrombosis, and play an important role in maintaining cardiovascular health.

References: advances in modern biomedicine, the beneficial role of copper in the cardiovascular system.

——FOOD AND NUTRITION BOARD, INSTITUTE OF MEDICINE. <Dietary Reference Intakes for VitaminA, VitaminK, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc[M]. >

Copper is the essential bone element in the human body:

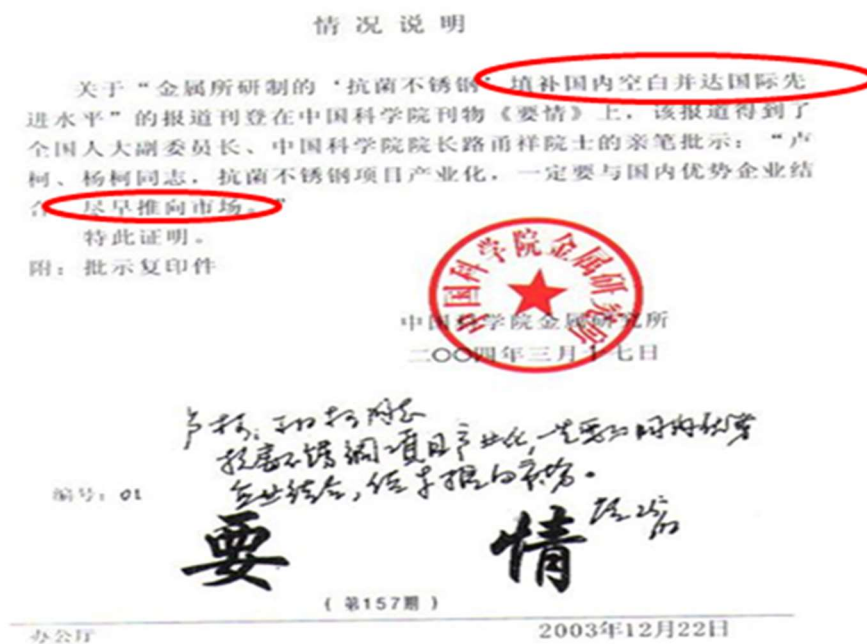
In 2001, FNB pointed out that copper is a cofactor for enzymatic reaction. In particular, collagen forms the essential lysine oxidase containing copper and collagen is an important component of bone tissue. Copper deficiency can inhibit bone growth and lead to osteoporosis.

References: FOOD AND NUTRITION BOARD, INSTITUTE OF MEDICINE. <Dietary Reference Intakes for VitaminA, VitaminK, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc[M]. >



央视新闻频道的报道 CCTV news channel Report

时任全国人大副委员长、中国科学院院长路甬祥院士的亲笔批示



Written by Lu Yongxiang, vice chairman of the National People's Congress and academician of Chinese Academy of Sciences, academician of the Chinese Academy of Sciences

Patent Show

证书号第270369号



发明专利证书

发明名称：一种奥氏体抗菌不锈钢

发明人：陈四红;吕曼祺;杨柯;董加胜;张敬党;吴平森

专利号：ZL 02 1 44683.0

专利申请日：2002年12月4日

专利权人：中国科学院金属研究所

授权公告日：2006年6月28日

本发明经过本局依照中华人民共和国专利法进行审查，决定授予专利权，颁发本证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。

本专利的专利权期限为二十年，自申请日起算。专利权人应当依照专利法及其实施细则规定缴纳年费。缴纳本专利年费的期限是每年12月04日前一个月内。未按照规定缴纳年费的，专利权自应当缴纳年费期满之日起终止。

专利证书记载专利权登记时的法律状况。专利权的转移、质押、无效、终止、恢复和专利权人的姓名或名称、国籍、地址变更等事项记载在专利登记簿上。



局长

田力普



第1页(共1页)

Authoritative Test

Antibacterial rate

Biosafety

The test report showed that the antibacterial rate of the antibacterial stainless steel against *Escherichia coli* was as high as 99.6%.



广微测
Gmicro Testing



中国认可
国际互认
检测
TESTING
CNAS L1747

广东省微生物分析检测中心

GUANGDONG DETECTION CENTER OF MICROBIOLOGY

分析检测结果

ANALYSIS AND TEST RESULT

报告编号 (Report №.): 2017FM08455R01D

测试微生物 The tested organism	无加工试样片接种后 直接得到的活菌数 Average of the number of viable cells of bacteria immediately after inoculation on the untreated test piece (cfu/cm ²)	无加工试样片接种 后放置 24h 得到活 菌数 Average of the number of viable cells of bacteria on the untreated test piece after 24h (cfu/cm ²)	抗菌试样片接 种后放置 24h 得到的活菌数 Average of the number of viable cells of bacteria on the antimicrobial test piece after 24h (cfu/cm ²)	抗菌活 性值 Value of antimicrobial activity	抗菌率 Reduction (%)
大肠杆菌 (<i>Escherichia coli</i>) ATCC 8739	9.3×10 ³	7.6×10 ⁵	3.2×10 ³	2.4	99.6

样品图片
Sample Picture



(以下空白 blank below)

The test report showed that the antibacterial rate of the antibacterial stainless steel against *Staphylococcus aureus* was as high as 99.9%.

广东省微生物分析检测中心

GUANGDONG DETECTION CENTER OF MICROBIOLOGY

分析检测结果

ANALYSIS AND TEST RESULT

报告编号 (Report No.): 2017FM05928R01Da

测试微生物	无加工试样接种后直接得到的活菌数 Average of the number of viable cells of bacteria immediately after inoculation on the untreated test piece (cfu/cm ²)	无加工试样接种后放置 24h 得到的活菌数 Average of the number of viable cells of bacteria on the untreated test piece after 24h (cfu/cm ²)	抗菌试样接种后放置 24h 得到的活菌数 Average of the number of viable cells of bacteria on the antimicrobial test piece after 24h (cfu/cm ²)	抗菌活性值 Value of antimicrobial activity	抗菌率 Antibacterial rate (%)
金黄色葡萄球菌 (<i>Staphylococcus aureus</i>) ATCC 6538P	7.1×10^3	3.4×10^4	<0.62	>4.7	>99.9

样品图片
Sample Picture:



(以下空白 blank below)

The test showed that the antibacterial rate of the antibacterial stainless steel against *Porphyromonas gingivalis* was 74.3%.



广微测
Gmicro Testing

广东省微生物分析检测中心

GUANGDONG DETECTION CENTER OF MICROBIOLOGY

分析检测结果

ANALYSIS AND TEST RESULT

报告编号 (Report №.): 2017FM08455R02D

测试微生物 The tested organism	无加工试样片接种后直接得到的活菌数 Average of the number of viable cells of bacteria immediately after inoculation on the untreated test piece (cfu/cm ²)	无加工试样片接种后放置 24h 得到活菌数 Average of the number of viable cells of bacteria on the untreated test piece after 24h (cfu/cm ²)	抗菌试样片接种后放置 24h 得到的活菌数 Average of the number of viable cells of bacteria on the antimicrobial test piece after 24h (cfu/cm ²)	抗菌活性值 Value of antimicrobial activity	抗菌率 Reduction (%)
牙龈卟啉单胞菌 (<i>Porphyromonas gingivalis</i>) ATCC 33277	1.6×10 ⁴	3.0×10 ⁶	7.7×10 ⁵	0.59	74.3

样品图片
Sample Picture



(以下空白 blank below)

The SGS test showed that the heavy ion migration of the antibacterial stainless steel was superior to that of the European standard.

**Test Report****Report No:** TJAFF170803986FDE**Date:** Aug 24 2017

Client name: Shenyang Rongrong Technology Co.Ltd
Client address: Room 602, No.155-2,Chuangxin Road, Hunnan District, Shenyang City, Liaoning Province
Sample name: 304Cu Antibacterial Stainless Steel
Batch No.: /
Product Date: /
Manufacturer: /

Above information and sample(s) was/were submitted and certified by the client, SGS quoted the information with no responsibility as to the accuracy, adequacy and/or completeness.

SGS Sample No.: TJAFF170803986
SGS Reference No.: TSNAF1701479301
Date of sample received: Aug 08 2017
Testing period: Aug 09 2017 ~ Aug 24 2017

TEST(S) REQUESTED:

Selected test(s) as requested by the applicant.

TEST RESULT(S):

Please refer to the next page(s)

Result Summary :

Test Requested	Comments
GB 4806.9-2016-Sensory (Appearance: the surface which contact with food should be clean; Plating layer without cracks, peel off; Welding part should be smooth, without porosity, cracks, burr)	PASS
GB 4806.9-2016-Sensory (Marinate: No smell)	PASS
GB 4806.9-2016- Specific Migration of heavy metal	PASS

Chinese shall prevail in this report.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This document cannot be used for publicity, without prior approval of the SGS.

SGS Authorized Signature

SGS-CSTC Standards Technical Services (Tianjin) Co., Ltd.

Page 1 of 2



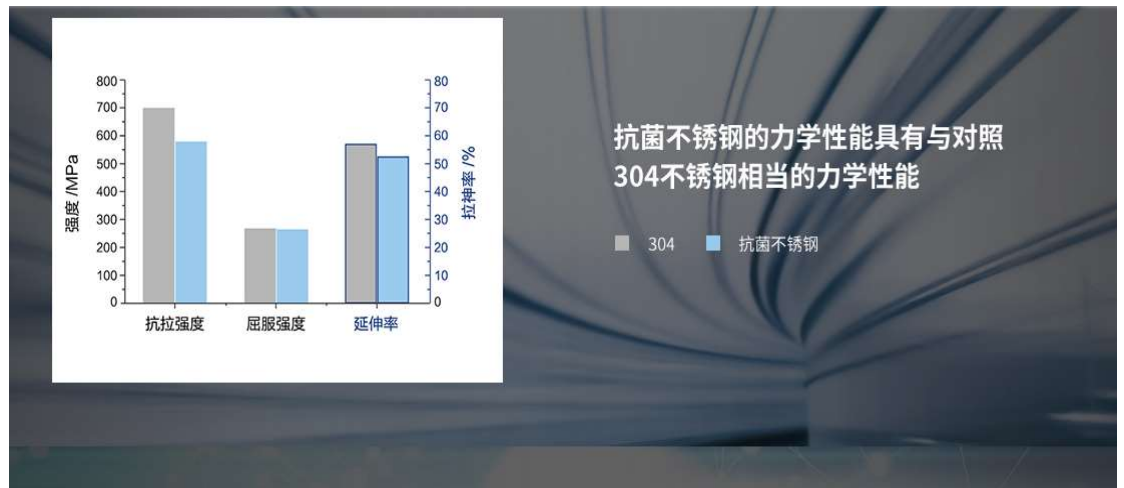
SGS-CSTC Standards Technical Services (Tianjin) Co., Ltd.
Agriculture and Food Laboratory

Unless otherwise agreed in writing, this document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <http://www.sgs.com/en/terms-and-conditions/Terms-e-Document.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

TJAF 093722

SGS Mansion, No. 41, The 5th Avenue TEDA, Tianjin, China 300457 t 400 - 691 - 0488 f (86-22) 65288133 www.sgs.com.cn
中国·天津市经济技术开发区第五大街41号SGS大厦 邮编: 300457 t 400 - 691 - 0488 f (86-22) 65288133 e sgs.china@sgs.com

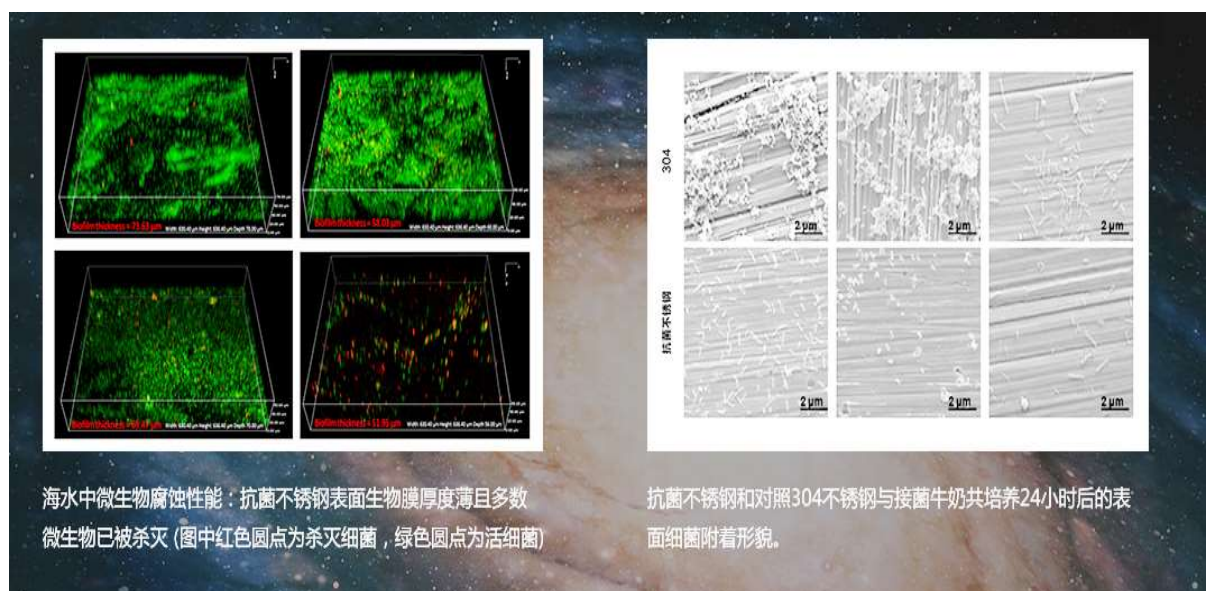
Member of the SGS Group (SGS SA)



The mechanical properties of the antibacterial stainless steel are comparable to those of the control 304 stainless steel.

The corrosion resistance of antibacterial stainless steel in normal saline was characterized.

The polarization curves of the antibacterial stainless steel (blue solid line) and the control 304 stainless steel (gray solid line) showed that the antibacterial stainless steel has the pitting potential equivalent to that of the control 304 stainless steel.



Microbial corrosion in seawater: antibacterial stainless steel surface biofilm thickness was thin and most microorganisms has been kill (red

dot represent dead bacteria and green dot represent live bacterial
Surface bacterial attachment morphology of antibacterial stainless steel
and control 304 stainless steel after 24 hour co-culture.

Main Products

Revolutionary new material Antibacterial stainless steel

Antibacterial stainless steel is a kind of novel integrated structural/functional material, which not only has the mechanical properties corrosion resistance and machinability of stainless steel but also has strong and broad-spectrum antibacterial function and exhibits over 99% sterilization rate against the common bacteria such as *Escherichia coli*, and *Staphylococcus aureus*. At present, Rongrong has successfully achieved the 100 tons industrial scale production of stainless steel which is being used in catering, food processing machinery, medical instruments, sanitary ware, water treatment and public health fields.

Catering Food storage Food processing machinery Water treatment

Revolutionary new material Scratch resistance stainless steel

To solve the readily scratch and wear problem of currently used household stainless steel products, we have developed scratch resistant antibacterial stainless to realize the long lasting brightness and beautiful appearance of stainless steel household products.

Revolutionary new material Antibacterial Titanium alloy

Antibacterial titanium alloy exhibits strong bactericidal effect against *Escherichia coli*, *Staphylococcus aureus*, *Porphyromonas gingivalis*, and *Streptococcus mutans* like typical pathogenic bacteria.

The strength of antibacterial titanium alloy is more than 20% higher than that of traditional titanium alloy of the same grade.

Antibacterial titanium alloy has good biocompatibility, comprehensive mechanical performance, mechanical processing performance, corrosion resistance and antibacterial performance, and can be used as implant material for stomatology and orthopedics

Revolutionary new material Biodegradable Magnesium alloy

Biodegradable magnesium alloy is an ideal material for implant internal fixation devices with the following advantages and features:

The degradable magnesium alloy can be degraded in the body hence there is no need for a re-surgery to remove the implant which could help in avoid patient's sufferings and pain.

Magnesium is an essential element in human body and plays an important role in human body;

With good biocompatibility and excellent bioactivity, magnesium ions can promote the proliferation and differentiation of osteoblasts; Its mechanical properties and density is nearly compatible to the bone tissue and density of bone.

Revolutionary new material high strength and high toughness maraging steel

high strength and high toughness maraging steel strength up to 2000MPa with good toughness. Areas of application: rocket and missile engines, aircraft landing gear, ultra-high pressure vessel, atomic energy and forging, extrusion dies, textile crochet, nail gun firing pin, high-speed elevator wire, car anti-collision beam and high strength and high toughness parts, etc.

Aircraft landing gear Rocket engine Atomic energy

high-speed elevator wire car anti-collision beam

Market Trend

The material industry is the basic industry of the national economy, especially the new materials, which will bring revolutionary change to the industry. In the future, the development direction and trend of steel materials must be high cleanliness, high uniformity, ultra-fine structure, obvious functionality, high precision and high added value. It is also the research direction and goal of Rongrong science and technology.