Institut "Jožef Stefan", Ljubljana, Slovenija

center za prenos tehnologij in inovacij
na Institutu "Jožef Stefan"

Licensing opportunity

Nano cellulose-reinforced alumina and zirconia ceramics with improved microstructural, mechanical and electro-conducting properties

Field of use
Ceramic applications in energy, telecommunication, automotive and medical industries

Current state of technology
Tested in the research pilot production system resembling existing industrial ceramics production lines.

Patent status
Patent(s) applied for but not yet granted

Publication
WO2018083268;
GB1618594;
Nature Nanotechnology 10, 277–283 (2015);
Nanoscale 10, 10488 (2018)

Developed by
Jožef Stefan Institute

Reference
TBA

Contact: dr. Levin Pal
Center for Technology Transfer and Innovation,
Jozef Stefan Institute,
E-mail:
tehnologije@ijs.si
http://tehnologije.ijs.si/

Background

A Slovenian and a Spanish research organization have developed a new type of alumina and zirconia ceramics with improved mechanical and electrically conductive properties achieved by nano-particulated cellulose filler. Complex shaped machining as well as electro-discharge machining is possible due to improved properties. Producers of ceramics, especially for automotive and biomedical applications are sought for licensing and technical cooperation.

Description of the Invention

During the course of scientific collaboration on fire retardant foams Slovenian and Spanish research organizations invented new formulation for carbon fibre reinforced and electrically conductive alumina and zirconia ceramics.

The core of invention is insoluble cellulose nanoparticulated material added as a filler to aqueous ceramic suspension followed by optimized steps of drying, green body formation and sintering to form reinforced electrically conductive ceramic article. This filler is - unlike hydrophobic carbon fillers (e.g. carbon nanotubes or carbon black allows) that are already on the market – composed of natural insoluble but hydrophylic nanoparticles (nanofibres and nanorods) of cellulose that are mixed into the aqueous solution of ceramic particles and consolidate their matrix.

The insolubility and nano-size of these hydrophilic nano-cellulose particles enable their homogeneous distribution across the ceramic matrix which is then dried and pressed into the green body preserving the homogeneous distribution of cellulose and ceramic nano-particles across the material. This homogeneous distribution enables the filler to be added at smaller quantities making the green body stronger and more resistant to machining as compared to green bodies reinforced with more concentrated and/or soluble and/or differently sized and/or less equally distributed fillers available on the market. High electrical conductivity is established during the sintering of machined green body upon which the cellulose nanofibres convert to carbon fibres. The equal distribution and low concentration of conducting carbon fibres is again preserving the valuable mechanical properties of ceramics made by the procedure described above. The idea of adding hydrophilic nano-cellulose filler rather than conventional hydrophobic carbon fillers to ceramic matrix was a result of integration of knowledge on ceramics development and nano-cellulose based hybrid and composite materials integrated from Slovenian and Spanish research organizations, respectively. A patent application with more detailed description of the filler and the procedure of production of these ceramics was filed at UK – IPO and WIPO.

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND
REPUBLIC OF SLOVENIA MINISTRY OF EDUCATION, SCIENCE AND SPORT
»The investment is co-financed by the Republic of Slovenia and the European Union under the European Regional Development Fund.«
KONZORCIJ ZA PRENOS TEHNOLOGIJ IZ JRO V GOSPODARSTVO

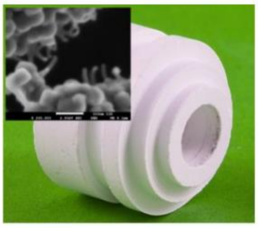
Researchers are looking for producers of alumina and zirconia ceramics, especially electrically conductive and (bio)inert engineering ceramics for automotive and biomedical applications. They wish to license out the technology. Technical cooperation is also offered in the form of facilities and the know-how of involved research institutes and researchers on how to implement the technology with slight modifications to existing industrial production scales of the companies interested in licensing in the presented technology.

Main Advantages

Improved mechanical properties (Hv=20 GPa) allow complex shaped machining prior to sintering.

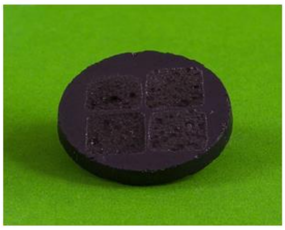
High electrical conductivity (400 S/m) is achieved at extremely low percolation thresholds due to nanosized filler that is equally distributed across the material. Electrical conductivity is triggered during sintering upon which the nano-cellulose filler is turned to conductive carbon fibres.

Electro-discharge machining (EDM) is also possible due to favourable electrically conductive properties of the material.



Improved microstructural and mechanical properties strength (Hv=20 GPa) allow complex shaped machining prior to sintering. Incorporated nanocellulose filler in form of fibres can be seen on the SEM image (top left corner).

Nanocellulose-zirconia before (left) and after (right) SPS sintering. It turns black due to *in situ* graphitization of the nanocellulose. The black sample is highly electroconductive (400 S/m).



Electro-discharge machined (EDM) nanocellulose-alumina. EDM in the sintered phase is possible due to percolation threshold achieved at lowered carbon content.

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND
REPUBLIC OF SLOVENIA MINISTRY OF EDUCATION, SCIENCE AND SPORT
»The investment is co-financed by the Republic of Slovenia and the European Union under the European Regional Development Fund.«
KONZORCIJ ZA PRENOS TEHNOLOGIJ IZ JRO V GOSPODARSTVO