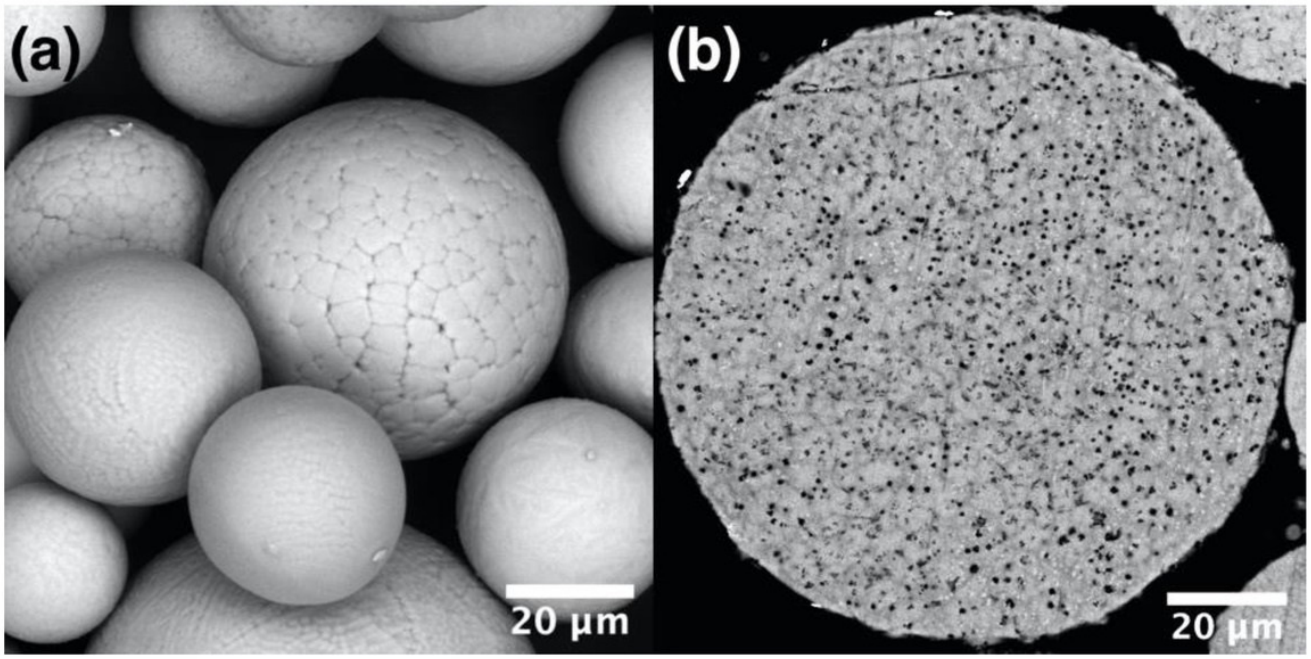
Take a look at the scientific results in Materials Science, Optical Electronics, Physical Chemistry, Quantum Chemistry and Civil & Structural Engineering



Scientists examined additive manufacturing of intermetallic TiAl-alloy using feedstock material

In this study researchers used laser powder-bed fusion (L-PBF) additive manufacturing (AM) with a high-temperature inductive platform preheating to fabricate intermetallic TiAl-alloy samples. The gas atomized (GA) and mechanically alloyed plasma spheroidized (MAPS) powders of the Ti-48Al-2Cr-2Nb (at. %) alloy were used as the feedstock material. The effects of L-PBF process parameters—platform preheating temperature—on the relative density, microstructure, phase composition, and mechanical properties of printed material were evaluated.

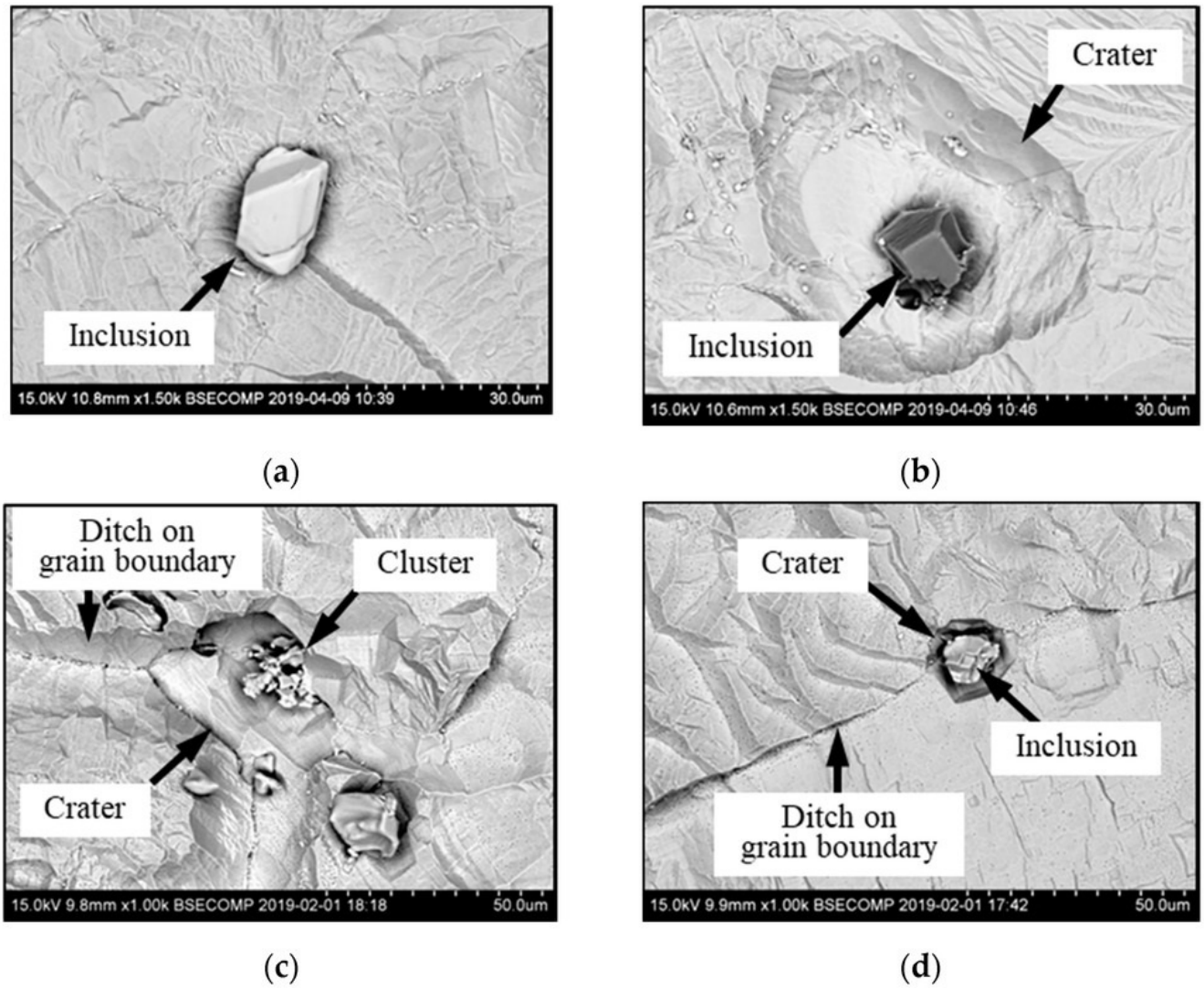
Compressive tests showed superior properties of AM material as compared to the conventional TiAl-alloy. However, increased oxygen content was detected in MAPS powder compared to GA powder, which resulted in lower compressive strength and strain, but higher microhardness. In this work it was demonstrated that pre-alloyed spherical GA and MAPS powders of TiAl-based alloy can be used to fabricate crack-free samples using the L-PBF process with high-temperature platform preheating.

This paper is a result of collaboration with Delft University of Technology (Netherlands).

Key words: selective laser melting, additive manufacturing, titanium alloy, microstructure, mechanical alloying, materials science

Publisher: Materials

Link to the publication



Researchers investigated effect of inclusions on the corrosion properties

of the two nickel-based alloys

Inclusions in steels and alloys are known to lower the resistance to deformation, as well as to lower the mechanical, corrosion and other properties. Studies of inclusions in nickel-based alloys are important since these materials could suffer from corrosion degradation in harsh operational conditions. This, in fact, could lead

to a pitting initiation around the inclusions.

In this study two industrial Ni-based alloys (alloy 718 and EP718) were investigated to determine the harmful effects of different inclusions on the corrosion resistance of Ni-based alloys. Specifically, the inclusion characteristics (such as composition, morphology, size, number and location) were determined for inclusions collected on film filters after electrolytic extraction and dissolution of a metal matrix around different inclusions on surfaces of metal samples after electrolytic extraction (EE). The most harmful effects on the corrosion resistance of metal were detected around sulphides and small carbides containing Mo, W, Cr.

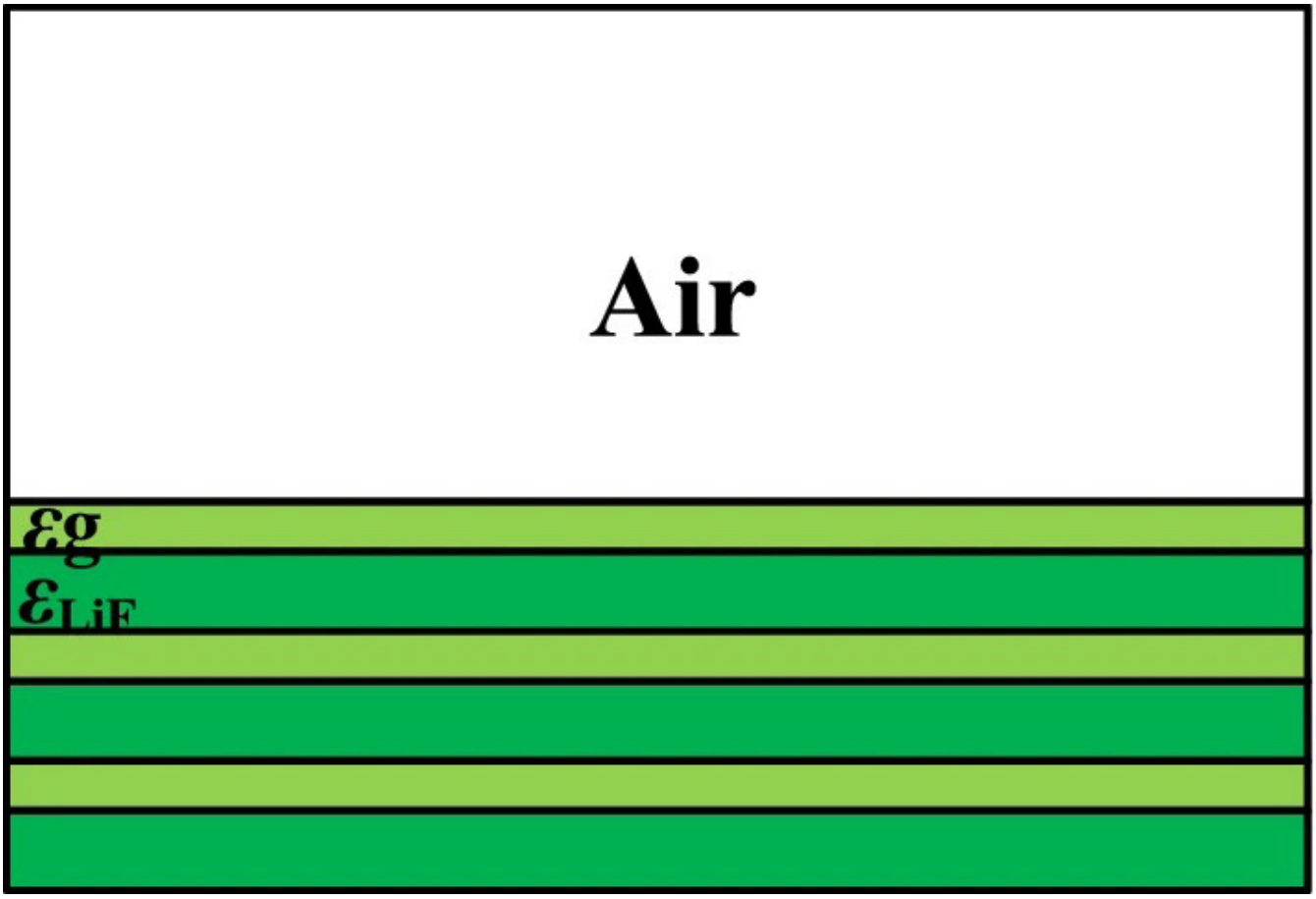
This study was conducted in collaboration with researchers from KTH Royal Institute of Technology (Sweden).

Key words: nickel-based alloys, corrosion, inclusions, oil and gas industry, electrolytic extraction, alloy 718, metallurgy, materials science

SPbPU Department: Institute of Advanced Manufacturing Technologies

Publisher: Metals

Link to the publication



Scientists got a systematic insight into the surface plasmon polaritons guided by the graphene based heterostructures

Graphene paves the way for the outstanding applications as it is one-atom thick and possesses perfect tunability properties. The main goal of the work was to reveal mode patterns of surface waves propagating in the graphene-based structures in the far-infrared region. Researchers study a broad variety of graphene structures starting with the simplest graphene/dielectric interface guiding conventional surface plasmon polaritons (SPPs) and ending up with more complicated cases.

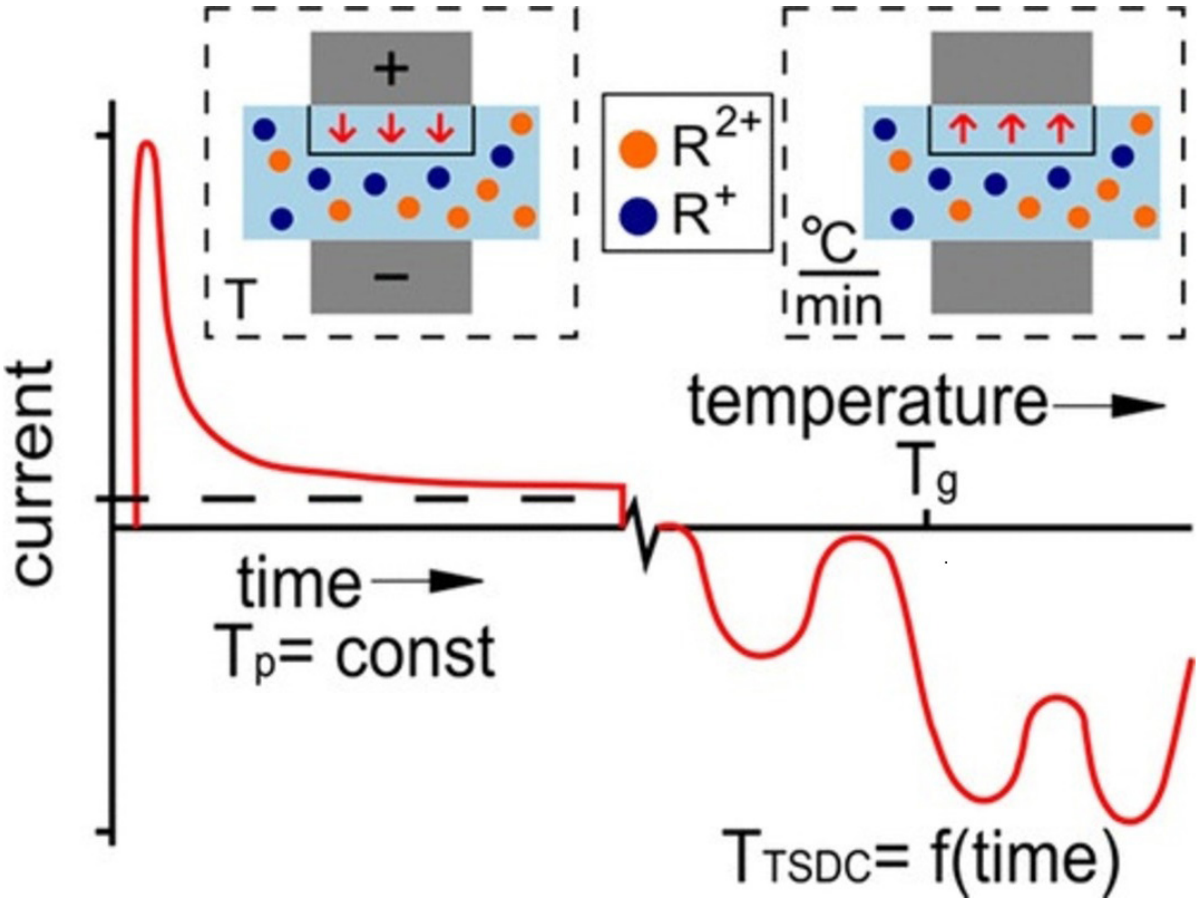
Two types of the structures with graphene and one auxiliary structure with LiF, a polar dielectric, have been theoretically investigated. By constructing a heterostructure comprising graphene and LiF one may benefit from the advantages of both, resulting in engineerable hybridized SPPPs propagating in both directions, i.e. either forwardly or backwardly. Scientists also conclude with presentation of the metamaterial composed of graphene and LiF building blocks allowing for an enhanced degree of freedom.

The study was performed in collaboration with Vilnius Gediminas Technical University (Lithuania), Center for Physical Sciences and Technology (Lithuania), and Aston University (United Kingdom).

Key words: graphene, metamaterial, surface plasmon polaritons, optical electronics

Publisher: Optical and Quantum Electronics

Link to the publication



Physicists studied mechanism of thermal charge relaxation in poled silicate glasses

In this paper data on thermally stimulated depolarization current (TSDC) study of the same poled glass in the temperature range 100–1000 K are analyzed. Researchers identified four specific temperature ranges in the TSDC spectrum of this glass, with each range being attributed to the charge relaxation processes of different natures. It was shown that the main charge relaxation takes place above the glass transition temperature with the activation energy coinciding with the one of viscous flow of silicate glasses, which is the switching of the glass network. All the data allowed authors to draw a schematic TSDC spectrum of silicate glasses in the full temperature range. For the first time, the TSDC spectrum of the same multicomponent silicate glass in the full temperature range, where TSDC bands can be principally observed, is presented and discussed.

The study was performed in collaboration with Alferov University and Ioffe Institute.

Key words: electric fields, activation energy, ions, amorphous materials, polarization, physical chemistry

Publisher: The journal of physical chemistry B

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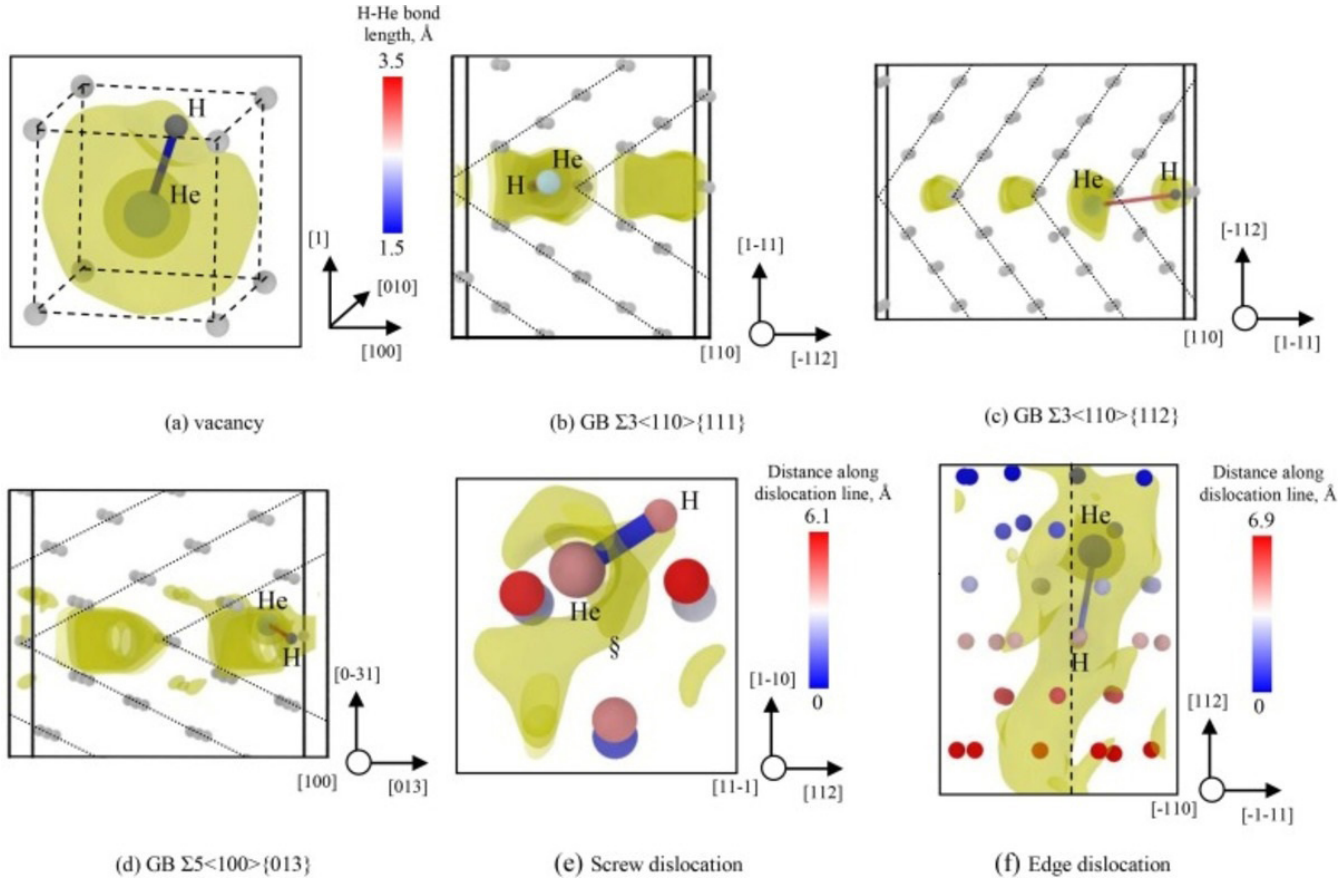

Ab initio study of the stability of H-He clusters at lattice defects in tungsten

The interaction of a H-He pair embedded in various types of lattice defects in the bcc tungsten, such as vacancies, tilt grain boundaries, a core of screw and edge dislocations has been studied using ab initio calculations. It was shown that H-vacancy and He-vacancy clusters are weaker traps for He and H single atoms, respectively, as compared to a single vacancy. H or He atom, solely, is strongly attracted to the studied grain boundary interfaces, while the mutual H-He interaction is negligible (close to the interaction in vacuum) if both atoms are placed in the adjacent trapping sites located on the grain boundary.

The obtained data are discussed in the frame of the thermal desorption spectroscopy results offering a better understanding of the detrapping stages of He and H isotopes under mixed plasma exposure conditions. This study was conducted in collaboration with researchers from Nuclear Materials Science Institute (Belgium).

Key words: Ab initio, dislocations, grain boundaries, Helium, hydrogen, tungsten, quantum chemistry

Publisher: Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms

Link to the publication

(a) (b)

Researchers work on improvement of performances of the gypsum-cement fiber reinforced composite

The novelty of this paper lies in the identification of the scientific patterns of the influence of thermal power plant waste (TPPW) on the hydration mechanism and the structure of the gypsum-cement binder (GCB). The classification of raw materials for the production of GCB has been developed taking into account the genesis, which contributes to the prediction of the properties of composites. The features of the hydration phase formation and hardening of GCB have been studied taking into account the chemical, structural and morphological features of fly ash and slag. In addition, the microstructural, morphological, and thermal properties of the cured binders at a 28 day cure were determined.

For the first time, scientific data on the properties of gypsum-cement fiber-reinforced composite using TPPW and microfiber have been obtained. The results show that the synergistic effect of gypsum-cement binder, TPPW, and polyamide or basalt microfiber improves the physicomechanical properties of a 28 day cured binder.

This study was conducted in collaboration with researchers from Belgorod State Technological University Named after V.G.Shoukhov, Far Eastern Federal University

Key words: gypsum, cement, fly ash, slag, fiber, materials science, civil and structural engineering

Publisher: Materials

Link to the publication

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