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NANOPOWDERCOATINGOFSAE52100BEARINGSTEELFORSURFACE IMPROVEMENTANDWEARREDUCTION

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ABSTRACT:

Yttria-stabilized zirconia (YSZ) film was deposited on to a metal substrate by electron beam–physicalvapor deposition (EB–PVD) at850 jC. The film was characterized by X-ray diffraction, scanning electronmicroscopyandtransmissionelectronmicroscopy.TheYSZfilmpredominantlyconsistedofthetetragonalphasewith a small amount of monoclinic phase. In addition, the film was composed of inverted triangular-basedpyramidal grains (T-grains) and inverted diamond-based pyramidal grains (D-grains). The T-grains were alignedin the direction and D-grains in Furthermore, striated lines of nanopores, which were strongly related to thethermal conductivity of the film, were observed in each YSZ grain. The pores are aligned in the direction in theplaneanddistributedacrossplanesinT-grains,andaligned

Keywords:nanocoating,EBPVD, pinondisc,abration,scratchtest

INTRODUCTION:

Thermal barrier coatings (TBCs) are applied to gasturbines,aircraftenginecomponentsandaerospaceenginecomponentstoincreasetheiroperatingtemperaturesandlifetimes[1–8].TBCsconsistofthree layers: an external thermally insulating oxidelayer(top coating), a thermally grownoxide layerandametallicbondinglayer(bondcoat),whichprotects theunderlyingmetalcomponentfromhigh-temperature oxidation. Yttria-stabilized zirconia(YSZ) is typically used as the top coat material inTBCsystems,especiallyYSZfilmsfabricatedbyelectron beam–physical vapor deposition (EB–PVD)have unique columnar structures [1–8]. The columnarstructuredfilmsareadvantageoustothermalinsulation that includes large strain and thermoshockapplications compared with lamella-structured filmspreparedbyothercoatingtechnique(e.g.,flamespraying orplasmaspraying).Thecolumnar

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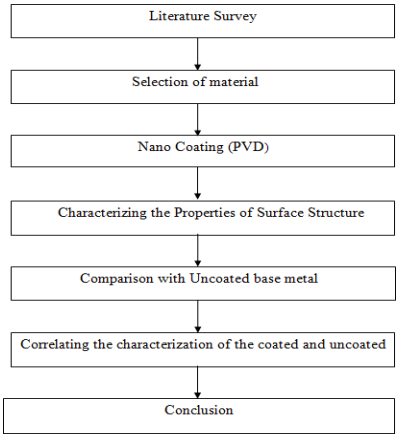
grains are thought to suppress cracking in the YSZfilm

Methods:

A Ni–Co–Cr–Al–Y alloy with a thickness ofabout 150Am was first deposited as bonding layerontoametalsubstratebylow-pressureplasmaspraying, and then surfaceof the bonding layer wasmechanicallypolishedtorequiretheflatsurface.Subsequently, an ingot of ZrO2–8 wt.%Y2O3wasevaporatedbytheEB–PVDmethod,anda 200-Am-thickYSZfilmwasdepositedontothe stationaryflatsubstrateat850jC[8].TheorientationoftheYSZfilmwasexaminedby X-raydiffraction(XRD)usingCuKaradiation.AftergrindingtheYSZfilmtopowder,thephasecompositionofthecoatingwasalsoidentifiedbyXRD.Surfaceandcross-sectionalmorphologiesoftheYSZfilmwereobservedbyascanningelectronmicroscope(SEM).paralleltothemetallic-bonding layer interface [6,7]. Furthermore,nanoporesarenaturallyformedinYSZgrainsfabricatedbytheEB–PVDmethod[1–6],andthenanoporesareconsideredtobestronglycorrelatedtothethermalconductivityofthefilm.Inordertoobtainatopcoatwithlowthermalconductivity,distributionandorientationofthenanoporesformedinYSZgrainsareneedtobecharacterizedanddcontrolledbytheoptimumprocessingconditions.



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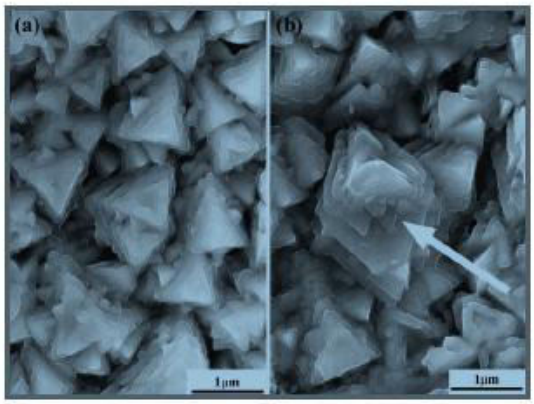

Fig. 4. SEM images of surface morphology of YSZ coating (a) triangle-shaped base of YSZ pyramidal grains (T-grain) and (b) diamond-shaped base (D-grain).

Fig.EBPVD

Physical vapor deposition (PVD) is a varietyof vacuum deposition and is a general term used todescribe any of a variety of methods to deposit thinfilms by the condensation of a vaporized form of thematerialontovarioussurfaces(e.g.,ontosemiconductor wafers). The coating method involvespurely physical processes such as high temperaturevacuum evaporation or plasma sputter bombardmentratherthaninvolvingachemicalreactionatthesurface to be coated as in chemical vapor deposition.VarintsofPVDinclude,inorderofincreasingnovelty:

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Fig.ballmilling.

To grind the crushed materials, and the ballmill is widely used in powder-making productionline including cement, silicate, new-type buildingmaterial, refractory material, fertilizer, ore dressingofferrousmetalandnon-ferrousmetal,glassceramics, etc. And the ball mill can grind variousoresandothermaterialswithdry typeandwettype. There are two kinds of ball mill, grate typeandoverfalltypeduetodifferentwaysofdischargingmaterial.Therearemanytypes ofgrinding media suitable for use in a ball mill, eachmaterialhavingitsownspecificpropertiesandThe critical speed can be understood as that speedafter which the steel balls start |rotating along thedirection of the cylindrical device; thus causing nofurther grinding. Ball mills are used extensively inthe Mechanical alloying process in which they arenot only used for grinding but for cold welding aswell, withthe purpose of producing alloys frompowders.Oneofmostcommonlyusedmills.

The ball mill is a key equipment advantages. Keyproperties of grinding media are size, density,hardness,andcomposition

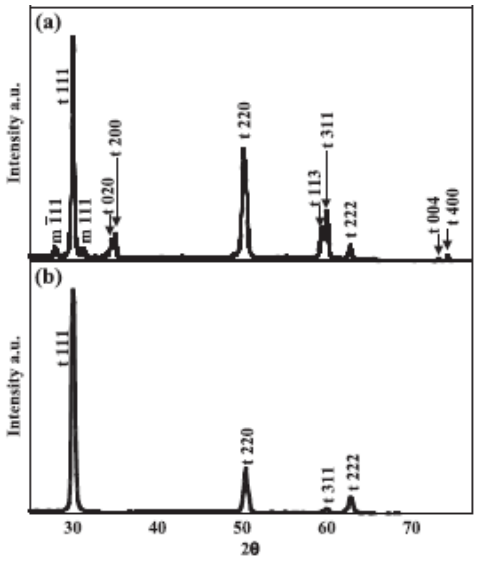

Fig. 5. Results of X-ray diffraction pattern. (a) X-ray powder diffraction pattern of the YSZ film and (b) from the YSZ film.

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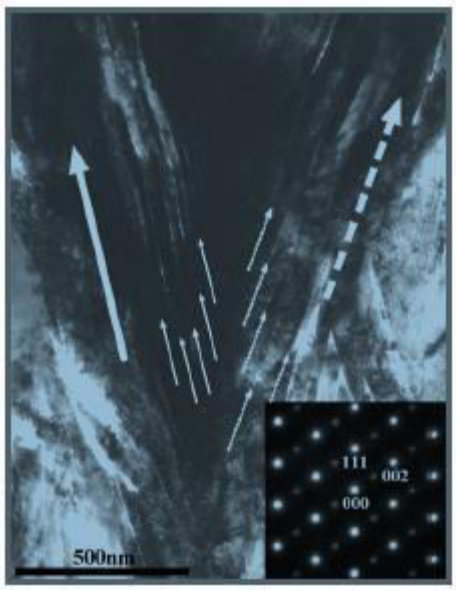

Pinondiscresultsforuncoatedspecimen:

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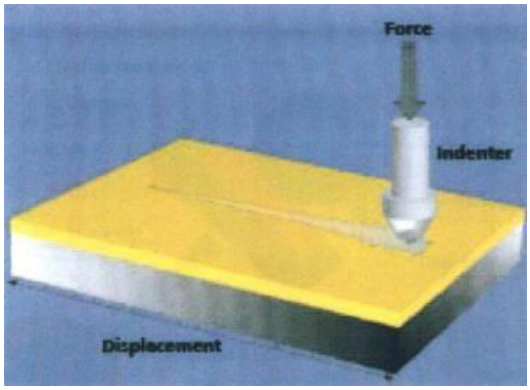
Time	B	Frictional force	Load	Coefficient of friction	F
10:09:29	2.03	3	0.68	0.01	-0.34
10:09:30	2.12	3	0.71	0.01	-1.36
10:09:31	1.75	3	0.58	0.01	-0.34
10:09:32	1.72	3	0.57	0.02	-0.34
10:09:33	1.74	3	0.58	0.02	-0.34
10:09:34	2.11	3	0.7	0.02	-0.34
10:09:35	1.3	3	0.43	0.01	-0.34
10:09:36	1.74	3	0.58	0.01	-0.34
10:09:37	1.91	3	0.64	0.01	-0.34
10:09:38	1.93	3	0.64	0.01	-0.34
10:09:39	2.44	3	0.81	0.01	-0.34

3.RESULTS

As can be seen, the thickness of YSZ film isestimated to be about 200 Am in the YSZ film iscomposed of many inversed pyramid shapedgrainswith their bases facing upwards to form distinctivepatterned structure, as shown in Fig. 3b. The interfacebetween the YSZ and bonding layer is fairly flat, butit is formed along the interface as indicated by thearrows.ThesurfacemorphologyoftheYSZfilm.

The bases of the YSZ pyramids can be improved anditsclassifiedastwotypes:oneistriangle-shaped(hereafterreferredtoasGrains)andtheotherisdiamond-shaped



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ScratchTestersarededicatedinstrumentsforcharacterizing the surface mechanical propertiesof thin films and coatings, e.g. adhesion, fracture anddeformation.Thescratchtester'sabilitytocharacterize the film-substrate system and to quantifyparameterssuchasfrictionandadhesivestrength,

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