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Selected Patents Related to Thermal Spraying

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Applications

Abradable Seal and Method of Producing Such a Seal. An air seal for use in a gas turbine engine includes reduced susceptibility to deflagration during operating conditions in which an excessive amount of seal material is liberated from the seal and ingested into the engine. The seal includes a seal substrate and a thermally sprayed metallic bond layer applied to the seal substrate. The bond layer includes nickel and aluminum. The seal also includes a thermally sprayed abradable seal layer applied to the bond layer. The abradable material is composed of aluminum powder and silicon powder forming a metal matrix and codeposited methyl methacrylate particles embedded as filler in the metal matrix. The filler is less likely to deflagrate compared to conventionally used materials such as polyester.

EP 1010861. F.C. Walden, G.L. Crawford, and W.J. Jr. Dalzell. Company: United Technologies Corp. Issued/Filed: Aug 24, 2005/Dec 14, 1999.

Alloy Composition and Method for Low Temperature Fluxless Brazing. A family of low-temperature brazing alloys wherein the alloy is utilized in the form of a filler metal or shim and consists of electroplated nickel on zinc shimstock, wherein the zinc shimstock includes zinc, aluminum, and silicon, with or without a small amount of lead, tantalum, or bismuth. The use of the brazing alloys for joining aluminum parts together or an aluminum part to a part of another metal, such as brass. Further, metallic coating could be thermally spray coated and powder metals could be utilized as the filler materials with equally acceptable brazing techniques. Using these techniques, the brazing could be accomplished at a temperature in the range of 750 to 1050 °F.

US 6913184. F Kostas, B.E. Dockus, R.H. Cheadle, R.H. Krueger, F. Liang, and M.S. Kozdras. Company: Dana Canada Corp. Issued/Filed: July 5, 2005/Nov 21, 2002.

Chamber Having Components with Textured Surfaces and Method of Manufacture. A component for a substrate processing chamber has a structure composed of aluminum oxide. The structure has a roughened surface having a roughness average of from about 150 to about 450 μm. A plasma sprayed ceramic coating of aluminum oxide is deposited on the roughened surface of the structure. The component may be a dome shaped ceiling of the chamber.

US 6933025. S.-N. Lin, M.D. Menzie, J.F. Sommers, D.O. Clawson, G.T. Mori, and L.L. Sharp. Company: Applied Materials, Inc. Issued/Filed: Aug 23, 2005/March 24, 2004.

Charging Member Having Titanium Oxide Outer Coating on Grit-Blasted Substrate. A process for producing a charging member by grit blasting a charging member substrate, plasma spraying a single-component outer coating consisting essentially of titanium dioxide powder directly to the grit-blasted stainless steel substrate, and the outer coating has a resistivity of from about 10^{-10} to about 10^{-3} ohms-cm.

US 6915095. J.L. Longhenry, T.R. Jaskowiak, K.W. Schlafer, and K.H. Taft. Company: Xerox Corp. Issued/Filed: July 5, 2005/June 16, 2003.

Component and Method for the Production Thereof. The invention relates to a component and to a method for the production of a component. Said component is made, at least partially, of metal. The metal area is at least partially extrusion-coated with thermoplastic synthetic material. An adhesion-promoting layer made of a thermoplastic material on one of the sides thereof which is oriented toward the synthetic material is arranged between the synthetic material and the metal area and a nonpositive connection is provided between the metal area and the synthetic material. The adhesive-promoting layer is applied to at least one part of the metal area, whereby at least one nonpositive connection is formed between the adhesion-promoting layer and the metal layer. Subsequently, the synthetic material is sprayed in such a manner that at least the surface area, oriented toward the synthetic material, of the adhesion-promoting layer arranged on the metal area is melted by the plastified synthetic material and is at least partially welded with the sprayed synthetic material.

WO 5061203. W. Aichele and R. Bald. Company: Robert Bosch GmbH. Issued/Filed: July 7, 2005/Oct 28, 2004.

Composite Foam Structures. A composite rigid foam structure that has a skin or coating on at least one of its surfaces. The skin is formed in situ by thermal spray techniques. The skin is bonded substantially throughout the surface of the porous substrate to the peripheries of the pores. The skin on the average does not penetrate the surface of the substrate by more than the depth of about 2 to 5 pores. Thus, thermal spraying the skin onto the rigid foam produces a composite that is tightly and uniformly bonded together without unduly increasing the weight of the composite structure. Both thermal conductivity and bonding are excellent.

US 6929866. B.E. Williams, J. Brockmeyer, and R.H. Tuffias. Company: Ultramet. Issued/Filed: Aug 16, 2005/Nov 16, 1999.

Composite Neutron Absorbing Coatings for Nuclear Criticality Control. Thermal neutron absorbing composite coating materials and methods of applying such coating materials to spent nuclear fuel storage systems are provided. A composite neutron absorbing coating applied to a substrate surface includes a neutron absorbing layer overlying at least a portion of the substrate surface, and a corrosion-resistant top coat layer overlying at least a portion of the neutron-absorbing layer. An optional bond coat layer can be formed on the substrate surface prior to forming the neutron-absorbing layer. The neutron-absorbing layer can include a neutron-absorbing material, such as gadolinium oxide or gadolinium phosphate, dispersed in a metal alloy matrix. The coating layers may be formed by a plasma spray process or a high-velocity oxygen fuel process.

US 6919576. R.N. Wright, W.D. Swank, and R.E. Mizia. Company: Bechtel Bwxt Idaho LLC. Issued/Filed: July 19, 2005/Feb 4, 2002.

Corrosion-Resistant and Brazeable Aluminum Material and a Method of Producing Same. A corrosion-resistant and brazeable aluminum material has an aluminum core, and a thermally sprayed layer formed on the core is composed of a brazing metal intermingled with zinc or its alloy. The brazing metal may be a mixture of aluminum and silicon, an aluminum-silicon alloy, a blend of the mixture with the alloy, or silicon. The brazeable aluminum material may be produced by blending a first powder of the brazing metal with a second powder of a corrosion-resistant substance including zinc, so as to prepare a powder mixture, and there thermally spraying the powder mixture onto the aluminum core.

CA 2112441. T. Kanai, M. Furuta, M. Kojima, and M. Ueda. Issued/Filed: Aug 9, 2005/Dec 24, 1993.

Donor Roll Coatings. A toner donor roll for use in a development apparatus of a electrophotographic apparatus is disclosed. The donor roll includes a conductive core and a ceramic outer coating over the conductive core. The ceramic coating is formed by thermal spraying a single homogeneous powder consisting of particles each of which contains a specific ratio of pure alumina and pure titania held together with an organic binder.

EP 1308795. J.L. Longhenry and M.L. Schlafer. Company: Xerox Corp. Issued/Filed: July 6, 2005/Oct 30, 2002.

Electrode Sheet for Capacitors, Method for Manufacturing the Same, and Electrolytic Capacitor. A method for manufacturing an electrode sheet for capacitors includes the step of thermally spraying mixed powder 6 in which intermetallic compound powder of aluminum and valve action metal other than aluminum, such as titanium, zirconium, niobium, tantalum, and hafnium, and aluminum powder are mixed, onto a surface of an aluminum foil, or supplying intermetallic compound powder of aluminum and valve action metal other than aluminum, such as titanium, zirconium, niobium, tantalum, and hafnium, and aluminum powder from different positions and thermally spraying the intermetallic compound powder and the aluminum powder onto a surface of an aluminum foil, to thereby form an aluminum-valve action metal alloy layer on at least one surface of the aluminum foil.

WO 5091318. H. Kawabata, A. Otaki, and T. Yamanoi. Company: Showa Denko K.K. Issued/Filed: Sept 29, 2005/March 24, 2005.

Ferrous Layer for a Sliding Surface, in Particular for Cylinder Running Surfaces on Engine Blocks, Applied by Means of Thermal Spraying. The invention relates to a ferrous layer on a sliding surface, applied by thermal spraying and a method for production thereof. The ferrous layer comprises further metallic, metalloid and/or nonmetallic elements and has an amorphous structure with finely distributed, nanocrystalline metal borides and/or metal carbides. The invention is characterized in that the ferrous layer comprises further nanocrystalline metal borides and/or metal carbides that can be generated by point heat introduction into the ferrous layer, after application of the ferrous layer and a subsequent surface treatment, in particular, honing. A sliding surface with high wear resistance, reduced friction, low production complexity and high dimensional accuracy can be generated by means of the point heat introduction. Said layer is particularly suitable for the cylinder running surfaces of internal combustion engines.

WO 5073425. C. Verpoort, M. Broda, T. Abeln, and G. Flores. Company: Ford Global Technologies, LLC. Issued/Filed: Aug 11, 2005/Jan 28, 2005.

Heat Exchanger and Method for Manufacturing the Same. A method for manufacturing a heat exchanger according to the present invention includes the steps of forming a thermally sprayed layer on a surface of an aluminum tube core by thermally spraying aluminum-silicon series alloy brazing material onto the surface of the aluminum tube core to obtain a tube, applying flux composite containing noncorrosive flux showing zinc substitution reaction onto a surface of the tube, combining the tube with the fin, and brazing the tube and the fin in an combined state.

WO 5061166. K. Minami and T. Yamanoi. Company: Showa Denko K.K. Issued/Filed: July 7, 2005/Dec 24, 2004.

High-Performance Hardmetal Materials. Hardmetal compositions each including hard particles having a first material and a binder matrix having a second, different material comprising rhenium or a nickel-base superalloy. Tungsten may also be used to a binder matrix material. A two-step sintering process may be used to fabricate such hardmetals at relatively low sintering temperatures in the solid-state phase to produce substantially fully densified hardmetals. A hardmetal coating or structure may be formed on a surface by using a thermal spray method.

WO 5089419. S.-R.S. Liu. Company: Genius Metal, Inc. Issued/Filed: Sept 29, 2005/March 16, 2005.

High-Temperature, Oxidation-Resistant Abradable Coatings Containing Microballoons and Method for Applying Same. An abradable coating composition for use on shrouds in gas turbine engines or other hot gas path metal components exposed to high temperatures containing an initial porous coating phase created by adding an amount of inorganic microspheres, preferably alumina-ceramic microballoons, to a base metal alloy containing high aluminum, chromium, or titanium such as beta-NiAl or, alternatively, MCrAlY that serves to increase the brittle nature of the metal matrix, thereby increasing the abradability and oxidation resistance of the coating at elevated temperatures. Coatings having a total open and closed porosity of between 20 and 55% by volume due to the presence of ceramic microballoons ranging in size from about 10 to about 200 μm have been found to exhibit excellent abradability for applications involving turbine shroud coatings. An abradable coating thickness in the range of between 40 and 60 mm provides improved performance for turbine shrouds exposed to gas temperatures between 1380 and 1800 °F. Abradable coatings in accordance with the invention can be used for new metal components or to repair existing equipment. The coatings can be applied to the metal shroud using thermal spray, processes that integrate sintering and brazing, or direct write techniques.

US 6916529. S.S. Pabla, F. Ghasripoor, Y.-C. Lau, L. Jiang, C.U. Hardwicke, and W.E. Martinez Zegarra. Company: General Electric Co. Issued/Filed: July 12, 2005/Jan 9, 2003.

Method to Reduce Thermal Stresses in a Sputter Target. The invention relates to a method to reduce thermal stresses in a sputter target during sputtering. The method provides the following steps: providing a target holder, applying a target material comprising indium-tin-oxide on the target holder by spraying, and introducing pores in the target material while applying the target material on the target holder. These pores leading to a porosity of at least 2% in the sprayed target material to reduce thermal stresses. The invention further relates to a sputter target having reduced thermal stresses and to a process for coating a substrate surface with indium-tin-oxide.

WO 5090631. H. Delrue, R. Vermeersch, W. De Bosscher, and F. Aps. Company: Bekaert Advanced Coatings. Issued/Filed: Sept 29, 2005/March 11, 2005.

Multilayer Pipe. A multilayer pipe having an inner layer of a thermoplastic polymer and a contoured, metallic barrier layer deposited thereon.

WO 5070671. J. Jarvenkyla. Company: Uponor Innovation AB. Issued/Filed: Aug 4, 2005/Jan 20, 2005.

Nonthreaded Expandable Pipe Connection System. A method for connecting tubular elements, particularly pipe for strings to be used in oil and gas wells, comprises: (a) locating a portion of a first tubular element within a portion of a second tubular element, (b) expanding the portion of the first tubular element and/or compressing the portion of the second tubular element to form a connection resulting from the interference between the external surface of the portion of the first tubular element and the internal surface of the portion of the second tubular element, in which, prior to assembly, one or both of the external surface of the portion of the first tubular element and the internal surface of the portion of the second tubular element is/are at least partially coated by plasma spraying with hard angular material. Preferably, protuberances of plasma sprayed hard angular material are formed on at least one of the mating surfaces of the connection.

WO 5061852. P. Head and P.G. Lurie. Company: BP Exploration Operating Co. Ltd., XL Technology Ltd. Issued/Filed: July 7, 2005/Dec 8, 2004.

Porous Coated Member and Manufacturing Method Thereof Using Cold Spray. Disclosed is a coated member on which a porous metal coating layer is formed and a method of producing the same. The method comprises providing the mother material, feeding powder having a metal composition, which includes at least two different metals selected from the group consisting of aluminum, magnesium, zinc, and tin and which is expressed by $xA-(1-x)B$ ($O < x < l$, where x is a weight ratio of A and B), onto the mother material, supplying high-pressure gas to the powder, applying the metal powder on the mother material by spraying the metal powder using the high-pressure gas through an supersonic nozzle, and heat treating the coated mother material to form the porous coating layer. In the method, it is possible to freely control the pore size and porosity of the coated member. Accordingly, it is available to various members for thermal and mechanical applications.

WO 5078150. K.H. Ko and H.Y. Lee. Issued/Filed: Aug 25, 2005/Feb 11, 2005.

Steel Reinforced Concrete Systems. Noncorroding reinforcing steel, and steel reinforced concrete, which has an adherent bond with hydrated concrete formed by a thermally sprayed hydraulically reactive layer of a material such as blast furnace slag on the steel surface.

US 6929865. J.J. Myrick. Issued/Filed: Aug 16, 2005/April 19, 2002.

Systems and Methods for Coating Conduit Interior Surfaces Utilizing a Thermal Spray Gun with Extension Arm. Systems and methods for applying a coating to an interior surface of a conduit. In one embodiment, a spray gun configured to apply a coating is attached to an extension arm that may be inserted into the bore of a pipe. The spray gun may be a thermal spray gun adapted to apply a powder coating. An evacuation system may be used to provide a volume area of reduced air pressure for drawing overspray out of the pipe interior during coating. The extension arm as well as the spray gun may be cooled to maintain a consistent temperature in the system, allowing for more consistent coating.

US 6916502. K.A. Moore and R.A. Zatorski. Company: Battelle Energy Alliance, LLC. Issued/Filed: July 12, 2005/Feb 11, 2002.

Diagnostics, Modeling, and Characterization

Method and Arrangement for Controlling Stresses Based on One-Dimensional Modeling in Sprayform Techniques. Method and apparatus for controlling stresses in a spray form process makes use of one-dimensional modeling in which characteristics of a geometrical point are quantified by iterative detection, such as taking a surface temperature reading using a pyrometer. This temperature information is used in a one-dimensional simulation to predict characteristics for a column from the point down through a spray-formed article to an interface with a substrate. The modeling technique can be used with a plurality of geometrical points to model the whole article, and the one-dimensional simulation can be integrated with robotic spray-forming controls to minimize residual stress in the spray-formed article.

US 6923241. A.D. Roche, S. Samir, C. Mgbokwere, and M. Lusk. Company: Ford Motor Co. Issued/Filed: Aug 2, 2005/Nov 27, 2001.

Quality Control During Thermal Spraying by Computer Processing of Digital Images. Thermal spray coating process is quality controlled by computer processing digital camera images to associate similar intensity regions with symmetrical flat geometrical shapes.

EP 1036856. P. Heinrich, W. Krammer, K. Landes, J. Zierhut, and T. Streibl. Company: Linde AG. Issued/Filed: Aug 17, 2005/March 9, 2000.

Feedstock

Advanced Mo-Based Composite Powders for Thermal Spray Applications. A molybdenum-base composite powder for thermal spray applications. The composite powder includes a Mo-Cr, Mo-W, or Mo-W-Cr alloy dispersion strengthened with molybdenum carbide (Mo_2C). The molybdenum-base composite powder may be combined with a nickel-base or cobalt-base alloy to form a two-phase powder blend. The coatings from such powders are made up of molybdenum-base alloy lamellae and, in the two-phase embodiments, nickel-base or cobalt-base alloy lamellae. The coatings exhibit improved corrosion resistance and strength while retaining good sprayability.

CA 2186924. S. Sampath and J.E. Vanderpool. Company: Osram Sylvania, Inc. Issued/Filed: Sept 13, 2005/Oct 1, 1996.

Thermal Spray Spherical Particles and Sprayed Components. Spherical particles of a rare earth (inclusive of yttrium)-containing compound and having a breaking strength of 10 to 300 MPa and an average particle diameter of 10 to 80 μm are suitable for plasma spraying.

US 6916534. K. Wataya, T. Maeda, and T. Tsukatani. Company: Shin-Etsu Chemical Co., Ltd. Issued/Filed: July 12, 2005/March 8, 2002.

Spraying Systems and Methods

An Assembly for Controlling the Gas Flow in a Plasma Spraying Apparatus. A plasma spraying assembly comprising a treatment chamber and a plasma spraying device located in the interior thereof is disclosed that further comprises an assembly for controlling the gas flow in the interior of the treatment chamber. In order to prevent a gas flow in the interior of the treatment chamber that whirls deposits to be created, a deflection device is provided that is located at least partially in the interior of the treatment chamber. Vertically below the treatment chamber, a collecting shaft is located. In the region between the treatment chamber and the collecting shaft, there is provided a basic element comprising baffle members, but leaving open a passage between the treatment chamber and the collecting shaft. In the interior of t he collecting shaft, a deflection element is located having essentially conical shape and towering into the passage of the basic element. The collecting shaft is in operative connection with the suction side of a blower and with a vacuum pump.

CA 2289870. S. Keller. Company: Sulzer Metco AG. Issued/Filed: July 5, 2005/ Nov 17, 1999.

Detonation Gun for Projection with High-Frequency Shooting and High Productivity. A detonation gun for thermal spraying formed by a combustion chamber and a barrel, with entrances for fuel and for oxidizer, one or more spark plugs for detonating the fuel-oxidizer mixture and one or more injectors for the introduction of the product into the barrel, the gun in the invention centers its characteristics on the incorporation of a direct-injection system of the fuel and oxidizer gases into the explosion chamber, producing explosive mixtures of different compositions according to the various zones in the explosion chamber, with a constrained volume existing in this explosion chamber in which only fuel is injected in such a way that it can generate high-energy explosions, maintaining the cyclic operation of the gun. The gun also incorporates in the barrel one or more annular injectors, which allow the feeding of various products, and especially coating powder, so that it is possible to increase the number of kilograms deposited on the substrate per unit of time and, in consequence, the gun's productivity.

EP 1228809. G.Y. Barykin and I.F. Altuna. Company: Aerostar Coatings, S.L. Issued/Filed: Aug 3, 2005/Oct 28, 1999.

High-Velocity Oxyfuel Wire Spray System. In a thermal spray process, a wire is fed into a flame-jet to heat said wire to the melting point, atomize and project at high velocity the droplets so formed against a surface to build up a coating of material on the surface. The wire is fed into the flame by aligning the cast plane of the wire with the flame jet by using a tubular member formed into a circular shape to provide sufficient length to guide wire and to provide the necessary twist amount to the wire to align the cast plane with the axis of the flame jet.

US 6924007. J. Browning. Issued/Filed: Aug 2, 2005/May 13, 2003.

Method for Coating a Workpiece. The invention relates to a method for coating a workpiece, in which a material is applied to said workpiece in a thermal spraying process. According to the invention, the spraying operation is monitored online, whereby properties of the particles contained in the spray jet are detected and made available as actual values. Said actual values are compared either directly to target values, or characteristics that are derived from the actual values are compared to the target values and if the actual values or characteristics deviate from the predetermined target values, process parameters for the thermal spraying process are automatically adapted by a regulator, based on a neuronal network.

WO 5085489. H. Abdullahi, A. Jakimov, M. Hertter, A. Kahny, and S. Schneidebanger. Company: MTU Aero Engines GmbH. Issued/Filed: Sept 15, 2005/ March 5, 2005.

Plasma Spraying Installation. Deflection system, for a plasma spray coating unit, comprises baffles within the spray chamber to prevent turbulence and entrainment of contaminants.

EP 1013791. S. Keller. Company: Sulzer Metco AG. Issued/Filed: Aug 10, 2005/ Oct 27, 1999.

Portable Manufacturing Facility for Manufacturing Antislip Flooring and Method of Manufacturing. The present invention provides a truck trailer manufacturing facility for coating workpieces such as metal plates or grating sections with a thermal spray antislip coating that provides a durable, high coefficient of friction surface on the workpieces. The manufacturing facility of the invention includes at least one surface preparing machine and at least one coating machine housed in a truck trailer. The present invention also provides a method of coating a workpiece with the truck trailer manufacturing facility.

US 6916375. W.S. Molnar, K.J. Heinl, B.P. Pelto, and J.J. Schulte. Company: W.S. Molnar Co. Issued/Filed: July 12, 2005/March 11, 2003.

System and Process for Solid-State Deposition and Consolidation of High-Velocity Powder Particles Using Thermal Plastic Deformation. The invention relates to an apparatus and process for solid-state deposition and consolidation of powder particles entrained in a subsonic or sonic gas jet onto the surface of an object. Under high-velocity impact and thermal plastic deformation, the powder particles adhesively bond to the substrate and cohesively bond together to form consolidated materials with metallurgical bonds. The powder particles and optionally the surface of the object are heated to a temperature that reduces yield strength and permits plastic deformation at low flow stress levels during high-velocity impact, but which is not so high as to melt the powder particles.

US 6915964. R.M. Tapphorn and H. Gabel. Company: Innovative Technology, Inc. Issued/Filed: July 12, 2005/April 5, 2002.

Thermal Spraying Method and Apparatus for Improved Adhesion Strength. A thermal spraying method includes the steps of: (1) preparing a speed-increasing means for adding energy to the heated material or the heating material to increase a flying speed of the material and (2) adding energy to the heated material or the heating material by the speed-increasing means in such a manner that a flying speed of the heated material or the heating material increases until the material reaches a surface of an object.

US 6913207. N. Miyamoto, K. Kodama, and I. Marumoto. Company: Toyota Jidosha Kabushiki Kaisha. Issued/Filed: July 5, 2005/April 2, 2003.

Thermal Barrier Coatings and Bondcoats

Bond or Overlay MCrAlY-Coating. It is disclosed a bond or overlay MCrAlY-coating for the use within a high-temperature environment for the protection of the base alloy of turbine blades and vanes. The MCrAlY-coating having a γ or γ/γ'-structure comprises a dispersion of β-NiAl and/or γ/β-MCrAlY particles. This provides a reservoir of aluminum reservoir to coatings wherein the reservoir replenishes the aluminum lost due to oxidation and interdiffusion during service. The β-NiAl and/or γ/β-MCrAlY is the aluminum reservoir and is applied by mixing appropriate powders with γ or γ/γ′ powders.

US 6924045. A.S. Khan, M. Konter, and R. Schmees. Company: Alstom Technology Ltd. Issued/Filed: Aug 2, 2005/May 3, 2002.

Thermal Barrier Coating Protected by Tantalum Oxide and Method for Preparing Same. A thermal barrier coating for an underlying metal substrate of articles that operate at, or are exposed to, high temperatures, as well as being exposed to environmental contaminant compositions. This coating includes an inner layer nearest to the underlying metal substrate comprising a ceramic thermal barrier coating material, as well as an outer layer having an exposed surface and comprising tantalum oxide in an amount sufficient to protect the thermal barrier coating at least partially against environmental contaminants that become deposited on the exposed surface and optionally an intermediate layer between the inner and outer layers comprising alumina. This coating can be used to provide a thermally protected article having a metal substrate and optionally a bond coat layer adjacent to and overlaying the metal substrate. The thermal barrier coating can be prepared by forming the inner layer comprising the ceramic thermal barrier material, optionally forming the intermediate layer comprising the alumina over the inner layer, and then forming the outer layer comprising the tantalum oxide over the intermediate (inner) layer.

US 6933066. B.A. Nagaraj, J.F. Ackerman, W.R. Stowell, and C.-P. Lee. Company: General Electric Co. Issued/Filed: Aug 23, 2005/Dec 12, 2002.

Thermal Barrier Coating Protected by Thermally Glazed Layer and Method for Preparing Same. A thermal barrier coating for an underlying metal substrate of articles that operate at, or are exposed to, high temperatures, as well as being exposed to environmental contaminant compositions. This coating comprises an inner layer nearest to the underlying metal substrate comprising a ceramic thermal barrier coating material having a melting point of at least about 2000 °F (1093 °C), as well as a thermally glazed outer layer having an exposed surface and a thickness up to 0.4 mils (about 10 μm) and sufficient to at least partially protect the thermal barrier coating against environmental contaminants that become deposited on the exposed surface, and comprising a thermally glazeable coating material having a melting point of at least about 2000 °F (1093 °C) in an amount up to 100%. This coating can be used to provide a thermally protected article having a metal substrate and optionally a bond coated layer adjacent to and overlaying the metal substrate. The thermal barrier coating can be prepared by forming the inner layer comprising the ceramic thermal barrier coating material, followed by depositing the thermally glazeable coating material on the inner layer, and then thermally melting the thermally glazeable coating material to form the thermally glazed outer layer.

US 6933061. B.A. Nagaraj, B.A. Boutwell, T.J. Rockstroh, and W.D. Scheidt. Company: General Electric Co. Issued/Filed: Aug 23, 2005/Dec 12, 2002.