consolidation of nanoparticles is not a very promising approach. An alternative technique for producing hardmetals with the disperse substructure of carbide grains at ultrahigh (CIP) in pure hydrostatic conditions has been developed. The new hardmetals thus obtained have dual properties of high strength and unique superductility under compression. The large-size tools based on these alloys have commercially demonstrated a record-breaking impact resistance an order of magnitude higher than that of the currently available standard hardmetals tools.

4:10 PM

(PACC-S3-006-2022) Processing of High Entropy Metal Carbides: A New Class of Ultrahigh Temperature, Irradiation Resistant Ceramics

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We have implemented a solvothermal synthesis process to synthesize high entropy metal carbides of Mo-Nb-Ta-V-W. The synthesis process is appealing because the reaction occurs at a high temperature (upwards of 2000°C), which allows the carbides to undergo reaction-driven alloying and form single phase solutions of nanopowders without the need for later thermal treatments. Our full single-phase nanopowders can also allow full densification to occur at lower sintering temperature (near 1600°C), creating a finer grain size distribution. The solvothermal synthesis technique consists of mixing metal chlorides and carbon powder in the presence of molten lithium. We have produced binary, ternary, quaternary, quinary, and senary metal carbides through systematic manipulation of elemental composition, resulting in solid solutions of (Nb-Ta)C, (Nb-Ta-W)C, and (Mo-Nb-Ta-W)C, determined from X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS). Rietveld refinement was used to deconvolute the XRD data and confirm the phase compositions of the different carbides to reestablish precursor amounts and optimize the solid solution powders. Then, through a spark plasma sintering process, dense samples of compositionally complex ceramics have been produced.

PACC6: Refractories in The Americas

Refractories

Room: Mirage (Level B)
Session Chair: Dana Goski, Allied Mineral Products

1:30 PM

(PACC-S6-001-2022) Recycling of spent catalysts from Fluid Catalytic Cracking (FCC) as refractory feedstock (Invited)

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In the last fifty years, the significant expansion of the industrial, commercial and agricultural sectors was accompanied by a huge increase in the production of petrochemical products and intermediates, as well as refined fuels like gasoline, diesel fuel, kerosene, jet fuel, naphtha, and gas oil. Fluid catalytic cracking (FCC) catalysts cannot be regenerated and they are fully replaced by fresh ones when their performance drops below the limits of acceptability. Apart from raw materials and energy consumption for their production, spent catalysts are mostly disposed in landfills leading to serious environmental pollution and human health problems. Most FCC catalysts consist of zeolites as active components embedded in a silica-alumina matrix made of amorphous phases and clays. The relatively high contents of alumina and silica make the spent FCC catalysts candidates for alumina-silica refractories. Moreover, extraction of the active component lanthanum is sought due to the industrial strategic character of rare earths. In this work, the collaborative research performed on the potential of "as spent" FCC catalysts and powders obtained after La-extraction for alumina-silica refractories is presented. The work has been performed on three "as spent" catalysts with different amounts of La.

2:00 PM

(PACC-S6-002-2022) Characterization of MgO-C bricks with different fused magnesia aggregates

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The influence of fused magnesia (FM) on the corrosion resistance, mechanical behavior and thermal evolution of MgO-C bricks was studied. Three qualities of electrofused magnesia were used as main raw material to form three bricks identified as A (purity 97.6 wt%), B (purity 98.2 wt%) and C (purity 98.7 wt%). Si and Al were used as antioxidants and phenolic resin was chosen as binder. Chemical resistance was evaluated through a cup test at 1600°C (2 h) using a steelmaking slag from LD converter. The mechanical evaluation was performed through compression tests at room temperature (air) and at 1400°C (argon). From the stress-strain curves different mechanical parameters were determined. Dilatometries up to 1400°C (in Ar) were performed to evaluate the thermal evolution. Microstructures were observed by optical microscopy and by SEM/EDS. The grain size of magnesia aggregates was determined. Besides, density and porosity of bricks were measured. Brick C presented a higher resistance to slag corrosion due to its highest purity and largest grain size of FM. At 1400°C, brick A presented the highest fracture strain (ε_F) and fracture energy (U_F). Thus, the corrosion resistance increases and the fracture parameters decrease when the purity of FM grains increases.

2:20 PM

(PACC-S6-003-2022) Lessons from Failure Analyses in Challenging Refractory Application Environments

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The never-ending drive for improved operational efficiency in the context of life cycle cost analysis and cradle to grave environmental stewardship are conspiring to catalyze improvements in refractory performance in a wide range of Industrial processes. Diagnosing the likely failure mechanism in order to enable process or refractory improvement recommendations can help to prevent similar events from reoccurring. A selection of representative example cases will be explored to appreciate the complex multi-variable environments of many refractory applications, with an eye toward identifying patterns of recurring contributors to failure across the varied environments. Observations will be drawn from a variety sources: laboratory testing, published literature, customized testing to simulate operating environments, and spent refractory characterization for a range of industrial applications. Alkali attack (alkali burst and/or alkali-based corrosion) is observed in many Industrial application environments, including but not limited to: wazardous waste incineration, biomass incineration, glass, cement, pulp & paper, chemical processing, petrochemical, zinc recovery. Lessons learned and unmet challenges identified will be discussed, providing the motivation for continued research and product development efforts.