# Introduction and context

- Issues of refractory performances
- Degradation factors in pig iron and steel making
- Characteristics and durability of refractories

#### Corrosion of refractories: the fundamentals

- Thermodynamics
- Wetting and infiltration, kinetics
- Mechanisms of transport and corrosion, Marangoni effect
- Slag structure and basicity, viscosity
- Refractory corrosion applications and study of industrial cases

## Reactions by liquid and gas, the key factors of corrosion

- Corrosion by liquid phases: direct and indirect dissolution, carbothermic reaction, oxido-reduction reaction, complex reactions with new compounds, dissociation, ...
- Corrosion by gas: reduction, oxidation, volatilization or dissociation under vacuum, condensation of corrosive vapors (Na, K, F, Zn, S, Cl), Boudouard reaction
- Steel making industrial examples

## Thermal, chemical and mechanical coupling

- Stress/strain induced by chemical reactions, phase changes, structural spalling ...
- Impact on the design of refractory lining
- Steel making industrial examples

#### Tools to study corrosion

- Testing methods for corrosion
- Traditional and advanced characterization methods
- Post-mortem analysis, sampling on industrial sites

# Impact of operating conditions on refractory lining wear - ways to minimize corrosion damage

- Adjusting the thermal cycle and the thermal gradient of the refractory lining
- Composition adjustment of the penetrant fluid (slag)
- Reducing the reactivity by changing the wetting characteristics
- Select well adapted refractories (raw materials, matrix, less porous and less permeable microstructure)
- Limit the penetration of the liquids into the refractory porosity by new precipitated solids that clog the pores
- Use of glazing or coating

#### Impact of refractory materials on inclusionary Cleanliness and steel quality

- Interactions of refractories and steel during the processes of secondary metallurgy
- Metallurgical consequences: control of oxide cleanliness, steel desulphurization, Ca treatments of deoxidation inclusions, elaboration of ultra-low carbon steels,
- Interactions of refractory materials and steel during continuous casting
- Metallurgical consequences: clogging, hydrogen pick-up, re-oxidation of the metal, control and prevention of non-metallic inclusions

#### Case studies considering different applications in ironmaking and in steelmaking

- Blast furnace
- BOF, EAF
- Vacuum degasser
- Steel ladle
- Continuous casting

#### **Quality Assurance**

- refractory quality control
- non-destructive testing
- customer service

#### New trends of refractory materials in the iron and steel industry

- Raw materials and design of new refractories
- Design optimization of linings regarding thermomechanical behaviour
- Simulations: computational fluid dynamic (CFD), thermomechanical modelling by finite elements, thermochemical software
- Energy savings
- Robotic solutions, maintenance methods, technology integration
- Recycling of refractories, health and safety

# Conclusion

