Quantifying the Composite Microhardness and Fracture Toughness of Iron Ore Sinter and their Relationship to Sinter Metallurgical Indices

M J Peterson[1]

1.
Senior Experimental Scientist, CSIRO Mineral Resources, Pullenvale Queensland 4609. Email: michael.peterson@csiro.au

ABSTRACT

An ability to predict an iron ore sinter's macro-scale metallurgical properties (e.g. tumble index (T.I.), reduction degradation index (R.D.I.), etc.) based upon its micro-scale properties (e.g. the modal proportion of different sinter phases and phase sub-types) is a key aim of sinter geometallurgical characterisation under the optical microscope. This is because the physical properties of sinter, e.g. porosity, permeability and strength, are of critical importance if it is to perform optimally during iron making. Microindentation techniques are one established and ready means of characterising an individual sinter phase's microhardness during microscopic sinter characterisation.

Microindentation testing was undertaken on a wide range of sinter phases from several pot grate sinter samples using the Vickers and Knoop indenters to determine the range and mean of sinter phase (e.g. SFCA) and phase-type (e.g. prismatic or platy) microhardness. From these, the mean fracture toughness, i.e. the potential for an existing fracture to propagate when the phase is exposed to an external stress, of each sinter phase and phase type was calculated. A value for the composite microhardness (CH) and composite fracture toughness(CFT) for each iron sinter was then calculated based upon the modal proportion of each sinter phase as determined by manual point counting.

The CH and CFT of each sinter type as well as for individual sinter phases (e.g. magnetite) was then compared to a range of metallurgical indices and major element sinter chemistry for the same sinter samples to determine the extent and nature of any correlation. Moderate to strong negative correlations between sinter CFT and sinter R.D.I. (R^2 = 0.89), sinter reducibility Index (R.I.) (R^2 = 0.81) and between sinter CH and sinter T.I. (R^2 = 0.96) indicate that trends in sinter microhardness can reflect trends in sinter macrohardness and therefore that the microindentation technique has the potential to characterise sinter macro-properties.