

# Observation of crack initiation and propagation in coal subjected to heating and cooling

*J. Kodama*<sup>1</sup>, *R. Naka*<sup>2</sup>, *T. Minami*<sup>3</sup>, *T. Sugawara*<sup>4</sup>, *A. Hamanaka*<sup>5</sup>, *K. Itakura*<sup>6</sup>, *G. Deguchi*<sup>7</sup>, *D. Fukuda*<sup>8</sup> and *Y. Fujii*<sup>9</sup>

1. Associate Professor, Hokkaido University, Sapporo 060-8628, kodama@eng.hokudai.ac.jp:
2. Graduate student, Hokkaido University, Sapporo 060-8628, ariminospice@eis.hokudai.ac.jp:
3. Graduate student, Hokkaido University, Sapporo 060-8628, odenn.gt.rad@gmail.com:
4. Technician, Hokkaido University, Sapporo 060-8628, suga@eng.hokudai.ac.jp:
5. Assistant Professor, Kyusyu University, Fukuoka 819-0395. hamanaka@mine.kyushu-u.ac.jp :
6. Professor, Muroran Institute of Technology, Muroran 050-8585, itakura@mmm.muroran-it.ac.jp:
7. Director, Underground Resources Innovation Network, Sapporo 007-0847, gota@mue.biglobe.ne.jp
8. Assistant Professor, Hokkaido University, Sapporo 060-8628, d-fukuda@frontier.hokudai.ac.jp:
9. Professor, Hokkaido University, Sapporo 060-8628, fujii6299@frontier.hokudai.ac.jp:

In underground coal gasification (UCG), controlling fracture in both coal seam and surrounding rock mass is one of important issues. Fracture development in rock mass increases risk for subsidence as well as ground water contamination, whereas crack initiation in coal seam might contribute in gaining efficiency because coal gasification can be activate by diffusing oxidizing agent in coal seam through cracks. Recently, it is reported that radial cracks are often initiated in coal from the surface of a combustion cavity in UCG model tests. Understanding process and mechanism of the crack initiation is significant for controlling fracture developed in UCG. In this study, crack initiation process during coal combustion of coal specimens with dimension of 5 cm x 5 cm x 2.5 cm was directly observed. A hole of 2.5 mm diameter was drilled at the center of specimens and thermocouples were attached in the specimens. Then, surface of the hole in coal specimens was heated using a gas burner for 120 minutes and cooled down in the atmosphere for 60 minutes with making a video of coal surfaces by video cameras. It was found that radial cracks frequently initiated from the hole at 500 °C or more in the heating process. It was also found that initiated cracks tend to propagate not only in the heating process but also in the cooling process. Coal specimens apparently showed volumetric contraction in the heating process. It can be interpreted that radial cracks were initiated and propagated by tensile stress induced by volumetric contraction of coal due to gas emission and condensation polymerization of hydrocarbon.

**Key words:** Underground coal gasification, Radial Cracks, crack initiation and propagation, Heating and cooling, Temperature