APS BLASTING

APS Blasting 3

NEW DEVELOPMENT ON ENGINEERING

BLASTING

Editor in Chief
Prof. WANG Xuguang

METALLURGICAL INDUSTRY PRESS

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PREFACE

The Asia-Pacific region and Russia are the most active regions globally in the field of engineering. There is no exaggeration to say that the development of blasting technology in the Asia-Pacific region and Russia is of far-reaching influence around the world.

In order to further promote the development of blasting industry in the Asia-Pacific region, China Society of Engineering Blasting has successfully held two sessions of Asia-Pacific Symposium on Blasting Technology in the year of 2007 and 2009 in China. According to the general consensus of the organizing committee, 3rd Asia-Pacific Symposium on Engineering Blasting will still be held in China. The International Conference on Physical Problems of Rock Destruction has been successfully held five times in Russia. Other Chinese experts and I were warmly invited to attend the Conference many times. To expand conference dimensions and share conference resources, the organizing committees of two conferences are decided to combine Asia-Pacific Symposium on Engineering Blasting with Conference on Physical Problems of Rock Destruction starting from 6th International Conference on Physical Problems of Rock Destruction in 2009. This year will hold 7th International Conference on Physical Problems of Rock Destruction also hosted by China Society of Engineering Blasting.

The Asia-Pacific Symposium on Engineering Blasting and the International Conference on Physical Problems of Rock Destruction are intended to strengthen the academic exchange and technological cooperation among various countries in Asia-Pacific region and Russia to enhance inter-disciplinary penetration, to explore the opportunities, challenges and counter-measures faced by blasting technology and physical problems of rock destruction in the new century and to forecast the application prospects of blasting technology in various fields to jointly promote the development of rock blasting technology and physical problems of Rock Destruction in the world.

The two conferences will offer valuable opportunities for experts, professors and engineers engaged in industrial explosives, engineering blasting, rock destruction and other relevant fields to enhance understanding and cooperation in the Asia-Pacific region and Russia. I hope and believe these two series international conferences will go ahead smoothly and successfully.

The two conferences have attracted intensive and extensive attention and support from various countries among the Asia-Pacific region and Russia as well as from Chinese engineering blasting industry. The organizing committee has received more than 110 papers and finally accepted 91 of which 39 papers

are from Russia, America, Canada, Japan, Korea, Sweden, India, Mongolia, Australia and Kazakhstan. The Symposium proceedings have been published, covering a wide range of subjects and presenting the leading technological innovations and achievements in industrial explosives, detonating facilities, rock fragmentation theory, physical problems of rock destruction, blasting vibration effect, blasting numerical simulation, blasting excavation, blasting demolition and others. At present, the deep spread of international financial crisis has an increasingly evident impact on the global real economy. It has become a severe challenge for the international community to promote global economy in the face of global financial crisis. But we believe these two conferences will further the development of industrial explosives and blasting technology not only in the Asia-Pacific region and Russia but also in the whole world and finally make new contributions towards a brighter future for human beings.

The two conferences have been well prepared thanks to the great effort and contribution from the organizing committee composed of experts of various countries. They have done a lot of work in publicizing the conference theme and calling for more papers. Here I' d like to express my truly gratitude to those experts both at home and abroad for their active support and assistance to our conference.

Prof. Wang Xuguang

President of China Society of Engineering Blasting

Academician, China Academy of Engineering

June 28, 2011

Contents

3 Rock Blasting

4 Special Blasting and Demolition Blasting

5 Blasting Vibration and Safety

1

Blasting Theory

Phenomenon of the Emission of Microparticles under Quasi-Static Loading of Rocks

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ABSTRACT: The article presents the results of experimental studies on the phenomenon of microparticle emission from the free surface of rock samples with a through-hole under uniaxial compression as a stress concentrator. The technique of experimental studies with the use of laser spectroscopy of particle sizes in the air has been developed. As a result of experimental studies the formation of microparticles and their detachment from the free surface at a certain level of stresses were documented. The phenomenon of microparticle emission is observed in samples of rocks with different physical and mechanical properties (dolomite, granite, limestone, and samples of concrete). Quantitative estimates were made of the emission of sub-micron particles in the range of 0.3 ~ 5.0 microns, depending on the operating voltage. Disperse composition of the particles, the dynamics of their formation depend on the petrographic characteristics of rocks, their degree of tension, and loading parameters. The quantity of particles generated during the testing of samples representing one type of rock in some cases differs significantly. This is explained by varying degrees of microfracturing of the samples, which presence predetermines the course of deformation and disintegration of the samples. In the emission of particles there is a mode of exacerbation——a dramatic increase of emission intensity, which precedes the disintegration of the sample. In rock disintegration control the dramatic enhancement of particle emission can serve an indicator of the forthcoming macrodisintegration. The research results suggest a conclusion that one of the mechanisms of sub-micron particle formation in the course of disintegration can be explained by the surface detachment of microscopic fragments. The established patterns and dependences have served a basis for the development of a radically new instrumental method for predicting men-induced phenomena resulting from the uncontrolled disintegration of the rock mass. A method has been development for the registration of fine particles with a laser aerosol spectrometer during the deformation and disintegration of rocks.

KEYWORDS: rocks; stress-strain state; emission of microparticles; laser spectrometry

Today, the aspects of sub-micron disintegration of rocks acquire particular importance, and it dictate the necessity of the assessment of conditions for the formation of sub-micron mineral particles in the processes of mineral mining[1,2]. On the one hand, rock disintegration facilitates its decomposition and separation of components in the course of mineral processing. On the other hand, the intensive man-induced disintegration of rocks results in the formation of ultra-fine particles that produces negative environmental effect. Besides, with the deformation and disintegration of rocks the formation of ultrafine particles characterizes the conditions of these processes that is a basis for the development of radically new methods of rock mass state control. The earlier studies[3~5] experimentally proved the existence of such a phenomenon as sub-micron particle emission in conditions of uniaxial compression of samples. The objective of this study is the research into objective laws governing the emission of sub-micron particle from the surface of rocks under uniaxial compression.

The following rock samples were investigated: dolomite, granite, limestone, urtite. The samples were of cubic (with an edge of 40 ~ 50mm) or cylinder (38mm diameter and 45 ~ 50mm height) shape. The rock samples were exposed to uniaxial loading in a hydraulic press with a certain load setting and concurrent registration of sub-micron mineral particle emission.

Based on the results of experiments Fig. 1 shows the distribution of sub-micron particle emission from different rock samples within a 0.3 to 5.0 micron range.

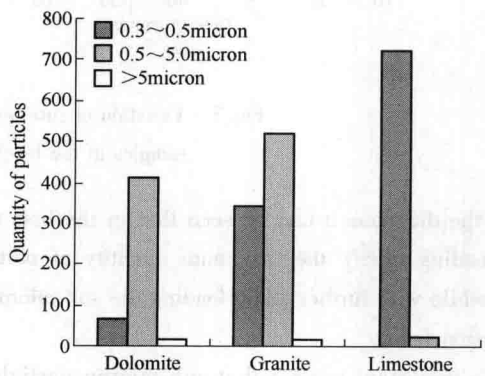

Fig. 1 Distribution of the emission of sub-micron particles for different rock samples at the stress level of 0.5 ~ 0.8 σ^*_{comp}

The results of experiments show a significant increase of particle emission on reaching a certain level of stresses. Fig. 2 reflects the distribution of the quantity of particles for dolomite (a) and urtite (b) samples depending on the relative level of loading.

From these diagrams it can be seen that at the relative level of loading $\sigma_{comp}/\sigma^*_{comp} < 0.6$ either no particle is observed or their quantity is negligible. The palpable increase of emission for these samples appears at a relative level of 0.8 σ^*_{comp}, where σ^*_{comp} is the ultimate compression strength, MPa.

It has been proved experimentally that the maximum quantity of particles is formed at the moment of loading, i. e., with the change of the stress-strain state. Fig. 3 shows the variation of sub-micron particle emission with time for granite (a) and urtite (b) samples.

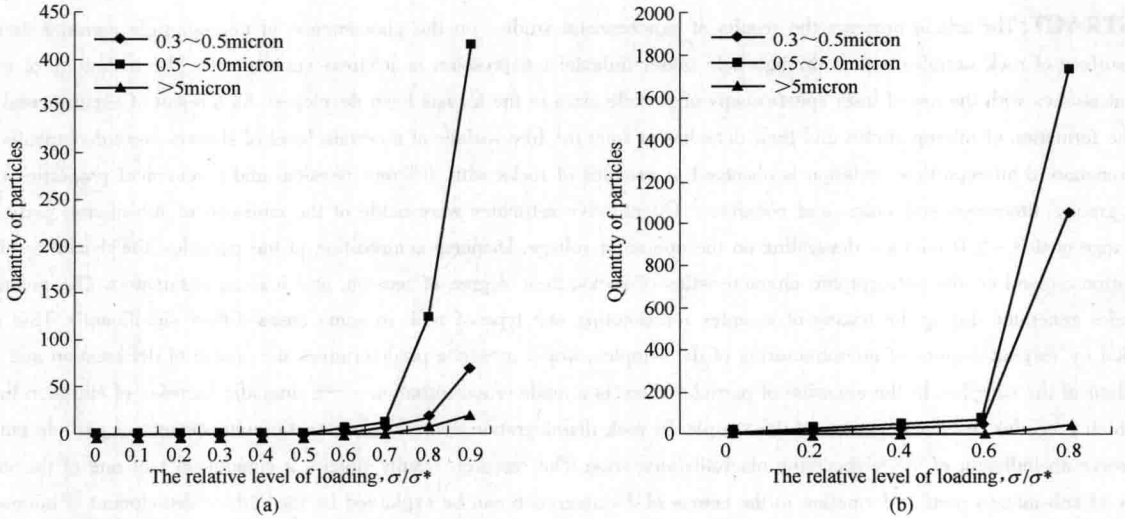

Fig. 2 Distribution of sub-micron particles with the loading of dolomite (a) and urtite (b) samples depending on the relative level of loading

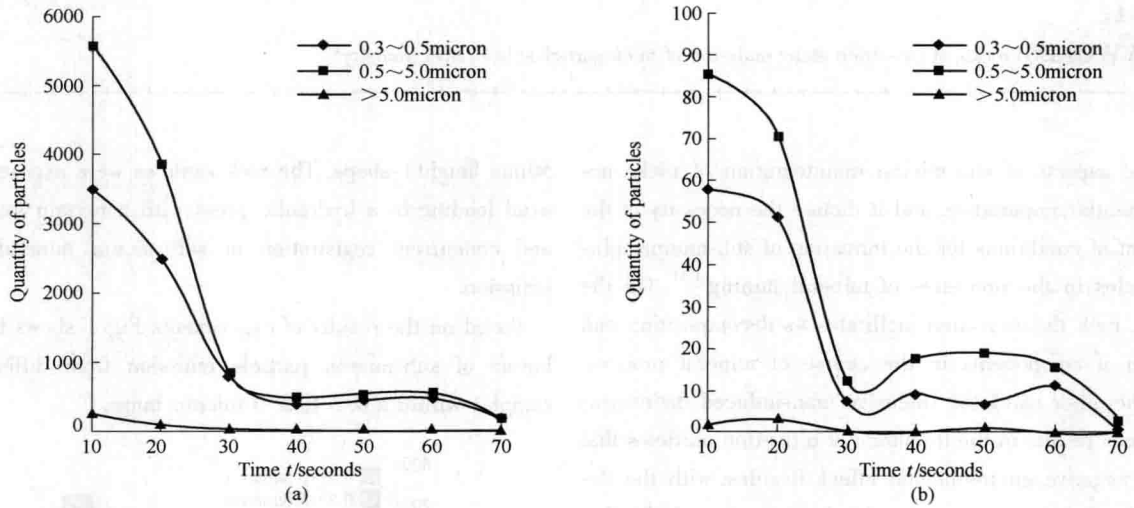

Fig. 3 Variation of sub-micron particle emission in granite and urtite (b) samples at the level of compression stress $\sigma_{comp} = 0.6\sigma^*_{comp}$

From the diagrams it can be seen that in the first ten seconds (loading time) the maximum quantity of particles is formed, while with further static loading the sub-micron particle emission fades.

It is important to note that sub-micron particle emission may significantly vary for one and the same rock type. This can be explained by a varying degree of sample microfracturing, which presence predetermines the course of deformation and disintegration processes. Fig. 4 reflects the distribution of particles for two red granite samples. From Fig. 4 it can be seen that at a relative level of loading $\sigma_{comp}/\sigma^*_{comp} = 0.6$ the quantity of particles is rather small. With further increase of load the dramatic growth is observed of sub-micron particle emission, which proves the formation of new and growth of the existing microfractures.