

any bond breakage as shown by the FTIR analysis. The grinding mills had reduced the size of particles until the tough-brittle transition size. Beyond this size the mechanical grinding machine was not able to reduce the particle size further more. Beyond this size the particles will undergo structural distortion where the crystal lattice of the particles will be distorted. As a conclusion, structural changes occurred during fine grinding process but the intensity of the structural changes very much depends on the grinding mechanism and the characteristics of the materials.

Pengisaran halus adalah proses pertengahan diantara pengurangan saiz dan pengaktifan mekanikal. Alata pengisar halus yang biasa digunakan adalah pengisar jet dan pengisar planet. Pengisar planet dan pengisar jet digunakan dalam projek ini dan bahan mentah yang digunakan adalah silika. Proses pengisaran dalam pengisar planet dilakukan dengan mengubah masa pengisaran dan jisim bahan manakala parameter operasi pengisar jet adalah kadar suapan, kelajuan pengkelas dan tekanan pengisaran. Bahan mentah yang dikisar dalam pengisar planet menunjukkan perubahan struktur yang lebih banyak berbanding dengan pengisar jet disebabkan oleh mekanisme pengisaran dan sifat fizikal dan kimia bahan mentah. Pertambahan nilai ketumpatan menunjukkan terdapat perubahan pada struktur kristal pada bahan yang dikisar. Analisis kebezaan terma menunjukkan pengurangan suhu perubahan fasa kerana partikel diaktifkan semasa proses pengisaran. Kehilangan beberapa puncak FTIR dalam sample yang dikisar dengan pengisar planet menunjukkan terdapat pemutusan ikatan antara molekul manakala sample yang dikisar dengan pengisar jet tidak menunjukkan sebarang pemutusan ikatan molekul. Pengisar akan mengurangkan saiz partikel sehingga saiz liat-rapuh. Selepas saiz in pengisar tidak akan mengurangkan saiz. Selepas saiz in partikel akan mengalami perubahan struktur. Kesimpulannya adalah partikel akan mengalami perubahan struktur semasa proses pengisaran halus tetapi keamatan perubahan struktur bergantung kepada mekanisme pengisaran dan ciri-ciri bahan mentah.

11. Please provide 5 keywords which describe your research project.

Fine grinding, structural changes, silica, limestone, jet mill, planetary mill

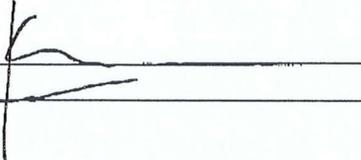
12. To best of your knowledge to which core research activities at USM your project may have contribute and/or strength? Please explain briefly.

This research will enhance the research in advance ceramics, composite and nanoparticles. The production of fine particles which are quantified in terms of its size and degree of crystallinity will be the feed stock materials for the above mentioned research.

13.	<p>This project has</p> <table border="1"> <thead> <tr> <th></th> <th>ITEMS</th> <th>YES</th> <th>NO</th> </tr> </thead> <tbody> <tr> <td>a.</td> <td>Resulted in human resources training</td> <td>√</td> <td></td> </tr> <tr> <td>b.</td> <td>Been patented</td> <td></td> <td>√</td> </tr> <tr> <td>c.</td> <td>Trained post graduate student</td> <td>√</td> <td></td> </tr> <tr> <td>d.</td> <td>Received other sources of funding</td> <td></td> <td>√</td> </tr> <tr> <td>e.</td> <td>Activated communication with other researchers both local and overseas.</td> <td>√</td> <td></td> </tr> <tr> <td>f.</td> <td>Other</td> <td>√</td> <td></td> </tr> </tbody> </table> <p>For each box√, please give details.</p> <ul style="list-style-type: none"> <li>• One PhD candidate, one research officer and three under graduate student were trained within the period of this grant.</li> <li>• This research has created an interest among the researchers within USM especially in materials engineering, SIRIM and also researcher in Japan who are involved in similar route of fine particle processing.</li> <li>• The spin off of this project has created an interest of the local cement producer to incorporate fine particle waste in their cement production.</li> </ul>		ITEMS	YES	NO	a.	Resulted in human resources training	√		b.	Been patented		√	c.	Trained post graduate student	√		d.	Received other sources of funding		√	e.	Activated communication with other researchers both local and overseas.	√		f.	Other	√	
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e.	Activated communication with other researchers both local and overseas.	√																											
f.	Other	√																											
14.	<p>Output of the projects and potential beneficiaries.</p> <ul style="list-style-type: none"> <li>• Quantified high quality fine particles for the materials engineering application.</li> <li>• The beauty of this projects was that the raw material used was from local resources so this will benefit the mineral related industry to value add the local resources rather than selling the low grade processed mineral.</li> </ul>																												
15.	<p>Organizational outcome</p> <ul style="list-style-type: none"> <li>• Training of staff in the field of fine grinding and mechanochemistry.</li> <li>• Fine particle processing and characterization laboratory setup.</li> <li>• Publications (local and international conferences and journal)</li> </ul>																												
16.	<p>National Impact</p> <p>This project has a big national impact especially to the mineral industry where Malaysia can start exporting high grade value added minerals in future. The local human resource training will enhanced the development of the industry in this area which is currently monopolized by the foreigners from Japan and Europe.</p>																												

17. List of reports and conference papers written

1. Morphology Of Ultra Fine Silica Particles By Impact Grinding. (2002) Samayamutthirian Palaniandy & Khairun Azizi Mohd Azizli. *Proceedings Of 11<sup>th</sup> Scientific Conference Electron Microscopy Society Of Malaysia*. Johor Bahru
2. Ultra Fine Particle Morphology!! Do Grinding Mechanism Influences it?. (2002) Samayamutthirian Palaniandy & Khairun Azizi Mohd Azizli. *Proceedings Of 11<sup>th</sup> Scientific Conference Electron Microscopy Society Of Malaysia*. Johor Bahru
3. Fine Grinding – A Complex Process (2003) Samayamutthirian Palaniandy & Khairun Azizi Mohd Azizli. *Proceedings Of Recent Advances in Materials, Minerals and Environment (RAMM) Conference, Penang, Malaysia*.
4. Morphology of Particles. Jet Mill vs. Oscillating Mill (2003) Samayamutthirian Palaniandy & Khairun Azizi Mohd Azizli. *Proceedings of 12<sup>th</sup> Scientific Conference Electron Microscopy Society Of Malaysia*. Langkawi, Malaysia
5. Structural Distortion of Silica Particle during Fine Grinding Process in Planetary Mill. (2004). Samayamutthirian Palaniandy, Syed Fuad Saiyid Hashim, Hashim Hussin and Khairun Azizi Mohd Azizli. *Proceedings of Simposium Mineral 2004*. Ipoh
6. Energy Studies of fine grinding process in Planetary Mill. (2004) Samayamutthirian Palaniandy, Khairun Azizi Mohd Azizli Syed Fuad Saiyid Hashim and Hashim Hussin. *Proceedings of the Malaysian-Japanese Seminar on Natural Resources and Energy Environment*. Kyoto University. 7-8 September 2004.
7. Structural Distortion of Talc During Foine Grinding Process in Jet Mill. (2004) Samayamutthirian Palaniandy, Syed Fuad Saiyid Hashim, Hashim Hussin and Khairun Azizi Mohd Azizli. *Proceeding of International Conference on X-Ray and Related Techniques in Research and Industry*. Penang, Malaysia.
8. Fine Grinding – A COMMREC Experience. (2004) Samayamutthirian Palaniandy, Syed Fuad Saiyid Hashim, Hashim Hussin and Khairun Azizi Mohd Azizli. *Proceeding of 2<sup>nd</sup> Colloquium of Postgraduate Research*. National Postgraduate Colloquium on Materials, Minerals and Polymers. (MAMIP 2004) Penang, Malaysia.

	<p>9. Effect of hardness on the particle morphology during fine grinding process in jet mill. Samayamutthirian Palaniandy, Syed Fuad Saiyid Hashim, Hashim Hussin and Khairun Azizi Mohd Azizli. (2004) <i>13<sup>th</sup> Scientific Conference Electron Microscopy Society Of Malaysia</i>. Putrajaya, Malaysia.</p>
18.	<p>List of scientific publication.</p> <ol style="list-style-type: none"> <li>1. Structural Defects in Silica During High Intensity Grinding Process. (2002) Samayamutthirian Palaniandy &amp; Khairun Azizi Mohd Azizli. <i>Malaysian Journal Of Science</i>. Vol. 21A (Special Issue) 2002.</li> <li>2. Structural Defects during Fine grinding Process. (2004) Samayamutthirian Palaniandy, Syed Fuad Saiyid Hashim, Hashim Hussin and Khairun Azizi Mohd Azizli. <i>Journal of Solid State Science and Technology Letters</i> Volume 11, 2 (Supplementary) October 2004.</li> </ol>
19.	<p>Please list our the equipment purchased for this project</p> <p>No equipment was purchased for this project. Only the raw material was purchased.</p>
20.	<p>Please provide other relevant information which you think would be useful to future research activities at USM, especially those that are related to the project which you have completed.</p> <p>Although the major portion of this research work concern mineral engineering but it can be clusters based research and inter disciplinary research as the researchers from various discipline.</p> <ol style="list-style-type: none"> <li>1. Materials engineering can contribute in terms of using the fine particle for product application.</li> <li>2. Environmental engineering can contribute in terms environmental impact assessment for this process.</li> <li>3. Mechanical and electrical engineering can improve the design of the grinding machine.</li> <li>4. Pure science such as physics and chemistry can contribute in terms of advancement of knowledge to understand the fundamental theory till the atomic scale.</li> </ol>
21.	<p>Please provide reprint(s), gallery prove(s) or chapter which should reflect the final results and findings of the research. All publication must acknowledge the grantee. A copy of all published articles or chapters must be sent to the R&amp;D office.</p> <p>SIGNATURE : </p>