Rolls-Royce

Meeting Minutes	
(a) **Project Name: Liquid Impingement Erosion CRIAQ**	
(b) **A-S #:**	c) **A-1 #: RNT.MAT.101**
(d) **Meeting Number: 40**	(e) **Date: February 19, 2013**
Rolls-Royce Canada – Energy Business – GT OBU 9545 Côte de Liesse Dorval, Québec H9P 1A5 Canada	**Second Party (if applicable)** Concordia, ETS, Ecole Polytechnique, MDS Coatings
(f1) Attendees: P. Jedrzejowski	(g1) Attendees: D. Ma (Concordia), W. Chen (Concordia), M. Mohammad (Concordia), D. Kevorkov (Concordia), M. Medraj (Concordia), M. Marzbali (Concordia), A. Dolatabadi (Concordia), J.E. Sapieha (Polytechnique); O. Zabeida (Polytechnique), G. Kamath (Polytechnique), F. Bridier (ETS), N. Kamkar (ETS), S. Durham (MDS Coatings)
(f2) Apologies:	(g2) Apologies: P. Bocher (ETS)
(h) Additional Circulation: B. Villien	(i) Additional Circulation:

Topics discussed at meeting:

LIE team meeting

(j) **Meeting # - Item #**	(k) **Topic of Discussion**	(l) **Actionee**	(m) **Reply Date**

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40-1	<u>Review of RR activities and master program</u> • International collaboration gives an opportunity for governmental funding of the program through International CRIAQ consortium. • Potential partners include universities and companies involved in EPSRC (Future Conventional Powergen Consortium Research) activity • Rolls-Royce Canada subjects of interests (not covered in the current program): o Erosion prediction o Lifing methods for blades exposed to the water droplet erosion • Detailed plan beyond 2013 is under development • Funding beyond 2013 strongly depends on the results from current activities • MDS Coatings has joined the project. There is still some paperwork that remains to be completed.	INFO S. Durham	 April 1
40-2	<u>Superhard coatings (Polytechnique)</u> • HIPIMS (high power impulse magnetron sputtering) technology was reviewed. • TiN and TiSiN materials were optimised for HIPIMS. Maximum of 10um can be deposited for each material. • 5um multilayer TiN/TiSiN structures were developed. • Samples for testing will be ready in the middle of March • The work on thick (>10 um) TiN/TiSiN multilayers continues. The next step will include incorporation of carbon to form TiSiCN composites.	O. Zabeida	March 15
40-3	<u>Damage mechanisms</u> • The methodology of damage analysis was reviewed. • Low plasticity burnished samples were analyzed for crack size and inclination and erosion mechanisms. The results will be compared with LSP and untreated samples. Permission must be obtained to publish the data. • Untreated baseline samples are being manufactured and will be tested in March April at Alstom laboratories. • It is difficult to find a material with an appropriate texture. A conclusion was reached that the analysed samples must not necessarily be representative to the blades. The emphasis should be put on the maximum difference in the texture.	P. Jedrzejowski F. Bridier	March 15 May 1
40-4	<u>Impact modeling</u> • Progress on modeling was presented. • For the incompressible fluid solid interaction (FSI) 1-way and 2-way coupling is modeled considering elastic solid. Pressure in fluid and stress in solid were calculated. • The compressible fluid FSI is limited to low speeds. • The 1-way coupling is considered as sufficient for the current program, however the 2-way coupling is also pursued for its scientific interest. • 1-way coupling with compressible liquid and elastic solid is planned to be operational by the end of March.	A. Dolatabadi	April 1

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40-5	<u>Multilayer coating for stress attenuation</u> • Multiple designs were proposed to manufacture at MDS Coatings. The samples should be prioritized in order to be able to prove the concept prior to the refinement of the microstructure.	D. Kevorkov	March 15
40-6	<u>Boronized diffusion coatings and composites and laser cladded samples</u> • A design of experiments was conducted. The best coatings show continuous TiB2 layer with TiB diffusion layer. The length and temperature of the process (72h and 1200C) raise concerns regarding the substrate microstructure. • The initial erosion tests show 4x less total mass loss in comparison with untreated sample. *For mass loss comparison the differences in density shall be also considered* • Composite coatings have relatively porous structure and in the initial testing did not show any improvement in erosion resistance. • Laser cladded Al2O3 samples showed improvement in the initial erosion tests	INFO	
40-7	<u>Nitriding</u> • The process is being optimised. The system has been stabilized in terms of gas flow, air leaks and repeatability. • According to the initial erosion result, it seems the compound layers are significantly vulnerable to WDE because of their adhesion strength and brittleness. • The diffusion layer showed promising results because it is not brittle and there is no defined interface. • Future activities will concentrate on adjusting nitriding process parameters to have better conditions for diffusion layer and coating the TiN layer by CAPVD on the nitrided Ti6AlV in order to have better adhesion strength for top layers.	INFO	
40-8	<u>Cold rolling</u> • Rolling process modeling was done and should be compared with the previous work done at Concordia. • Hole drilling is being set up at Concordia university to analyse the residual stresses on the fabricated samples. • The Measured residual stresses will be correlated with modeling and measured erosion resistance.	D. Kevorkov	April 1