**APC project meeting – October 4, 2013**

Teleconference call: 11:00 am – 12:00 pm

**Meeting participants:**

Amino: Trent Maki

ArcelorMittal: Isadora van Riemsdijk

CANMET: Kevin Boyle

Ford: Sergey Golovashchenko

Novelis: Brandon Hance, Richard Hamerton

U Waterloo: Michael Worswick, Jose Imbert, Tamjeed Rahmaan

U Windsor: Daniel Green

**Meeting minutes:**

Brandon Hance and Richard Hamerton were introduced to the partners. Then there followed a discussion on the sheet material characterization that is on-going. Mechanical testing of the DP600 and AA5182 at the University of Waterloo are complete and testing of TRP780 is still on-going. High-speed DIC was used in the testing enabling r-values to be determined at each strain rate. The data are currently being analyzed and it was estimated that the test data would be available for the partnership within the next month or two. Difficulties with the development of the electro-magnetic ring expansion test apparatus were also discussed. There was also some discussion on the possibility of carrying out disk-compression tests at different strain rates to obtain the yield stress in equibiaxial tension as this property is necessary for input into the anisotropic constitutive models that are being employed to simulate EHF.

Kevin mentioned that Marciniak tests with DIC and with electro-etched grids were currently under way and quasi-static FLD data for the three sheet materials would be available within one or two months. Due to some tooling modifications that are required, the hydraulic bulge tests will be ready to start in the near future.

The micromechanical modeling of DP steels requires knowledge of the flow behavior of each of the constituent phases: the request was put forth to obtain some ferritic steel and some martensitic steel sheet specimens that are approximately equivalent in composition to the phases in the current DP600 steel. Isadora said she may be able to find some suitable single phases steels. Michael indicated that the University of Waterloo would be able to do some testing of these materials at different strain rates. Kevin mentioned that CANMET was currently investigating similar single phase materials and that these data from a different project might possibly be made available to the APC partnership. In regards to the damage of AA5182, Kevin proposed that instead of tracking the void volume fraction as a function of strain (or strain rate) it might be more fruitful to investigate shear banding and the accumulated damage around 2nd phase particles.

Daniel gave an update on the characterization work being conducted at the University of Windsor: Javad successfully defended his PhD thesis on Sept. 6, 2013 and his thesis will be made available to the partners. Brent is still working on characterizing this DP600 in terms of its as-received and as-EH formed microstructure. Arash is also conducting the microstructural characterization of the AA5182.

Sergey gave an update on the on-going industrial trials at Amino: to date it has not been possible to hydro-mechanically draw a defect-free dash panel with the DP600 sheets. After extensive numerical simulations of the forming process conducted at Ford, drawbeads have been modified on the die but the sheet is not filling the die cavity in some locations and wrinkling and folding still occur in some places. The coefficient of friction that has been assumed in the numerical model is 0.08, but it would seem that 0.12 is more realistic. Michael offered information on a supplier that could provide lubricant that would help the forming process: Hydrodraw 625. Once the DP600 dash panels are preformed successfully at Amino, trials to hydro-mechanical draw the dash panel with AA5182 sheet material can proceed. Ford has built an EHF die which is ready to be used to complete the forming of the pre-formed dash panel shells.

Chris has completed a series of systematic free-formed EHF lab-scale tests on DP600 and AA5182 which shows that there is little or no improvement in formability when there is no impact of the sheet against the die wall. Chris plans to complete his MASc by the end of this year. Further die-formed EHF tests will be conducted at Ford to produce DP600 and AA5182 conical specimens which exhibit enhanced formability as a result of a significant impact against the die wall. Amir has completed a series of VUMAT subroutines for ABAQUS which incorporate different anisotropic yield criteria (Hill 48, Barlat-2D and Barlat-3D) as well as various hardening models (JC, KHL and modified KHL): the validation of these subroutines is waiting for the mechanical properties from the University of Waterloo to become available. Amir hopes to defend his PhD by the end of this year.

The micromechanical modeling of the high strain rate deformation of DP steel is being carried out using the representative volume element (RVE) method

The next project meeting was tentatively planned for either Nov. 19 or 22 so that people could conveniently attend the 1-day NADDRG symposium at Oakland University on Nov. 21.