LaMCoS Unité Mixte de Recherche 5259

Laboratoire de Mécanique des Contacts et des Structures

«Simulation of Cold Spray Process»

--Work progress report

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WORK FRAME

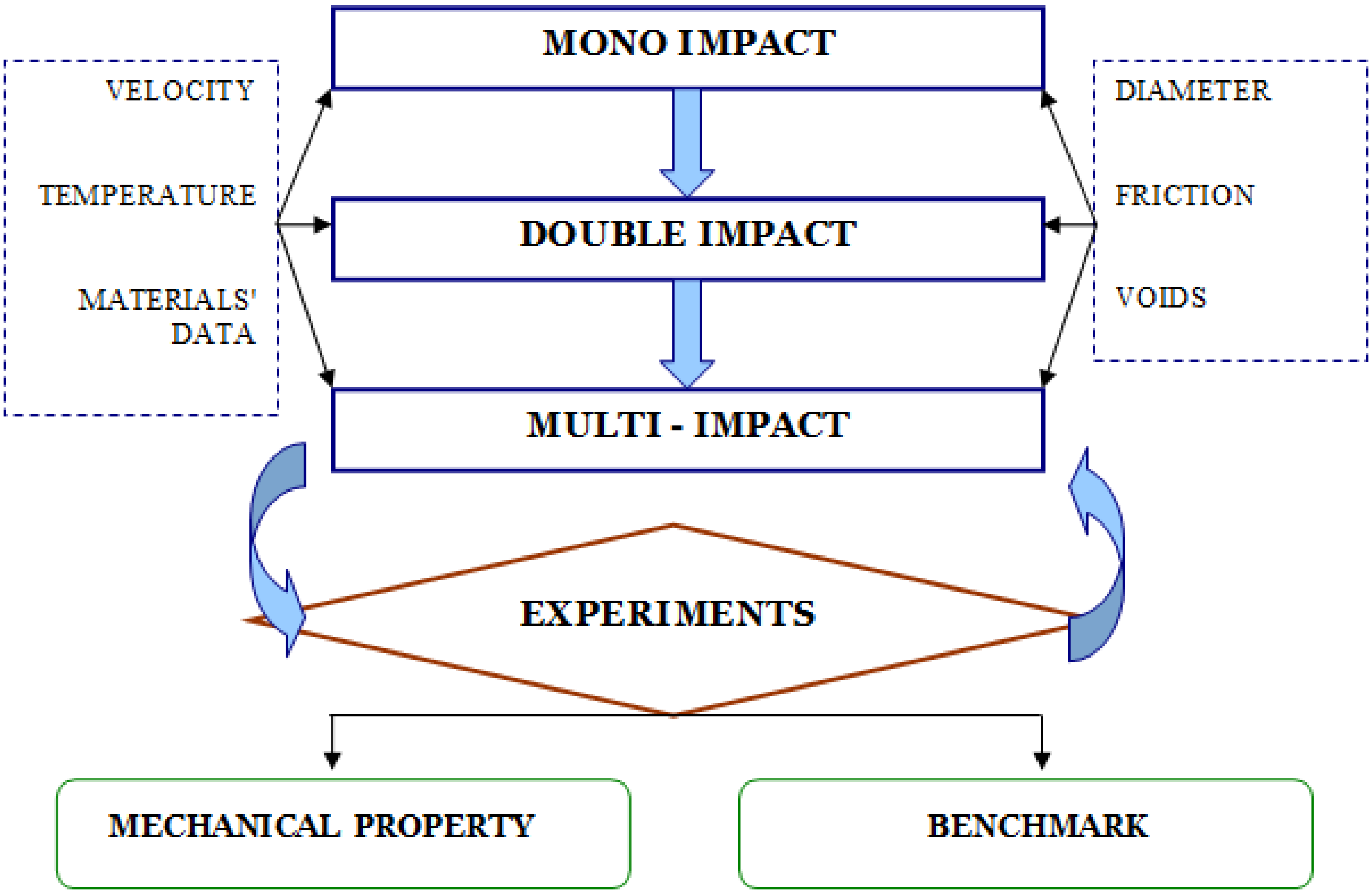
SET UP

Cu/Al

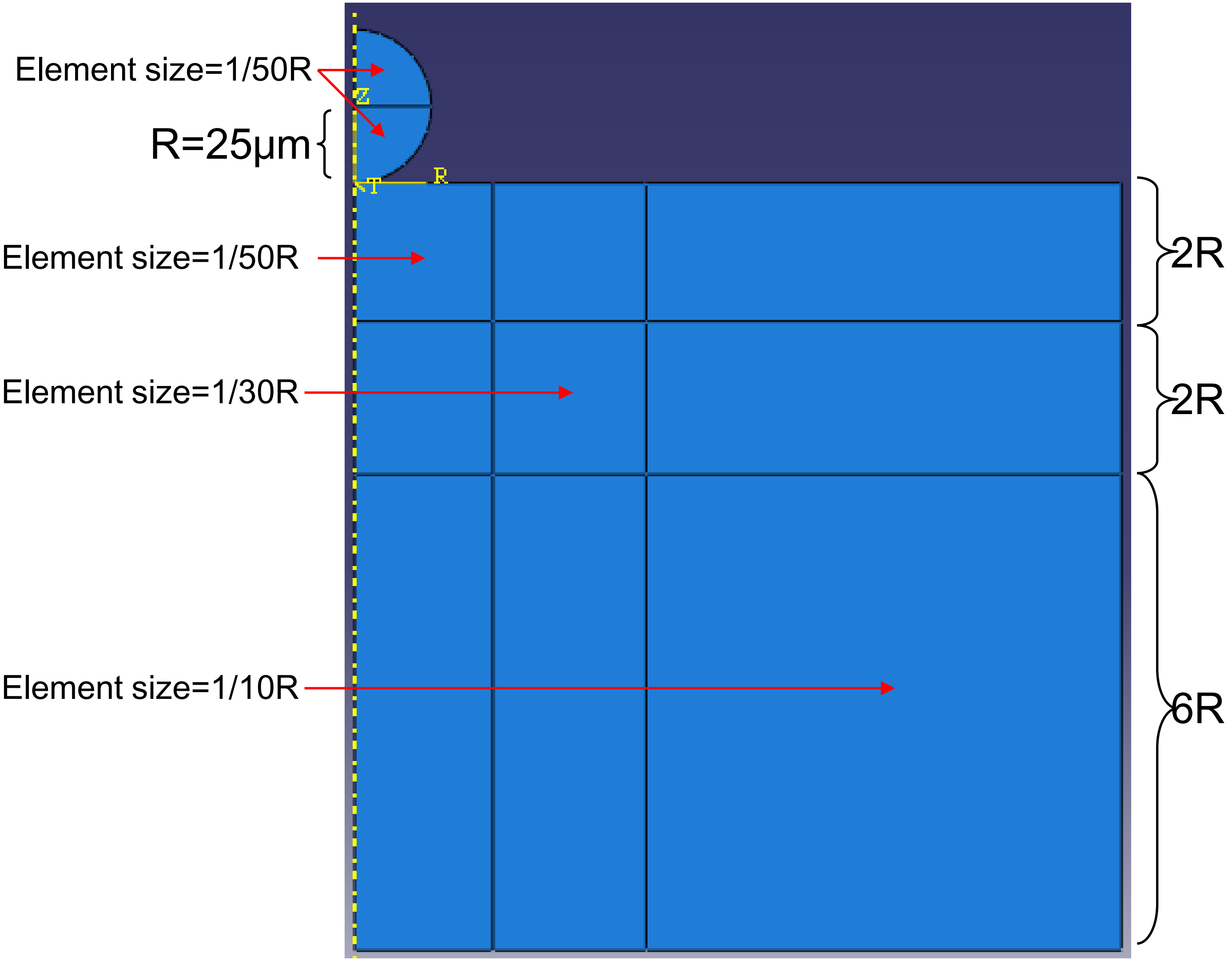
Al/Cu

Al/Al

CONCLUSION



•MODEL


Element size=1/50R
R=25µm
Element size=1/50R
Element size=1/30R
Element size=1/10R
2R
2R
6R

•MATERIALS

Property		Copper	Aluminum
Density(g/mm^3)		8.9e-3	2.7e-3
Elastic modulus(MPa)		1.26e5, 0.335	7.0364e4, 0.332
Plastic Johnson-Cook	A(MPa)	90	130
	B(MPa)	292	160
	n	0.31	0.34
	m	1.09	1
	C	0.025	0.015
	T_m(K)	1356	877
	T_f (K)	298	298

(g-mm-s-K-J)

•SIMULATION

NO°		#1	#2	#3
Material	particle	Copper	Aluminium	Aluminium
	substrate	Aluminium	Copper	Aluminium
Velocity		430m/s,600m/s	600m/s,700m/s	700m/s,780m/s,840m/s
Friction		0/0.3	0.3	0.3
Contact time		80ns/600ns	390ns	400ns
Contact angle		90°(normal impact)		
Contact type		Elastic-plastic		
Plastic model		Johnson-Cook law		
Element type		Particle & Substrate: CAX4R (axisymmetric, linear elements with 4 nodes, reduced integration,hourglass control)		
Adaptive meshing		1)ALE adaptive mesh domain,frequency 10 2)Remeshing sweeps per 30 increments 3)Preserve initial mesh grading 4)Seconder-order advection,half-index shift momentum advection		

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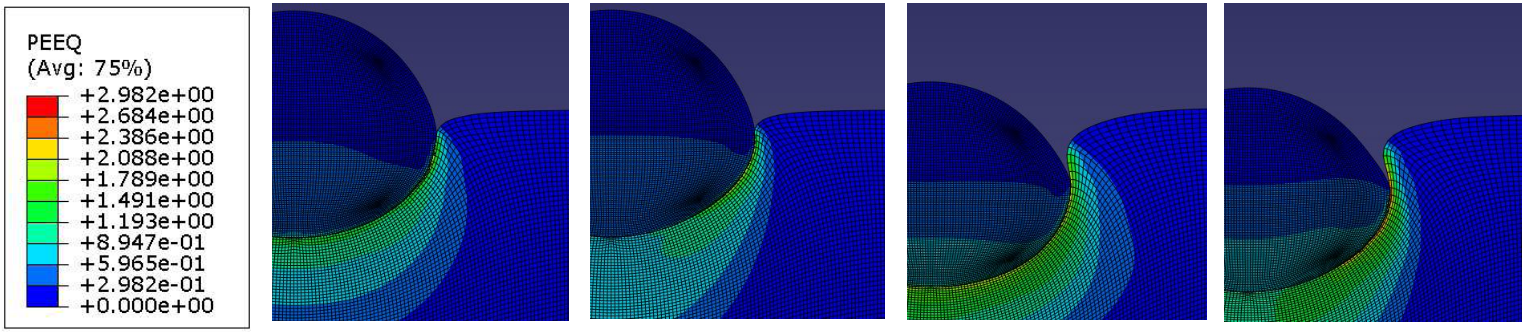


(a) 430m/s,f=0 (b) 430m/s,f=0.3 (c) 600m/s,f=0 (d) 600m/s,f=0.3

Figure 1 - Equivalent plastic strain distribution during the impact of *Cu* sphere against *Al* substrate after 80ns

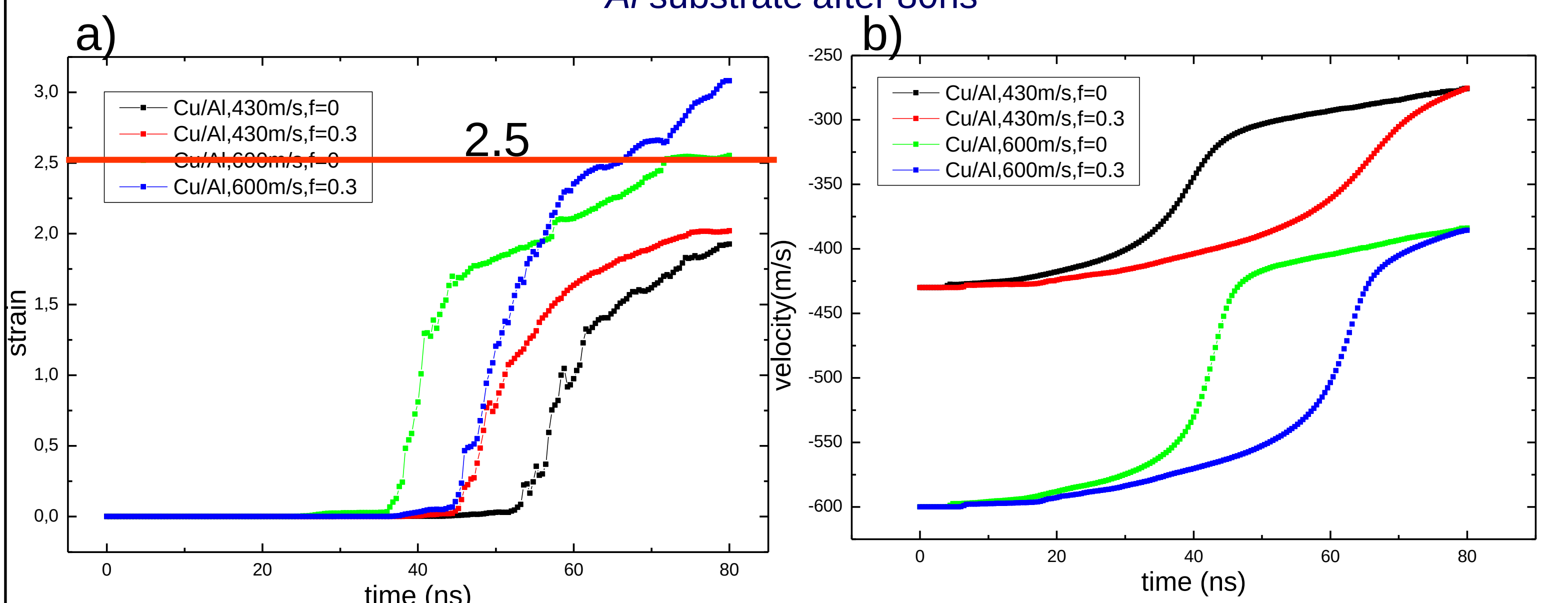
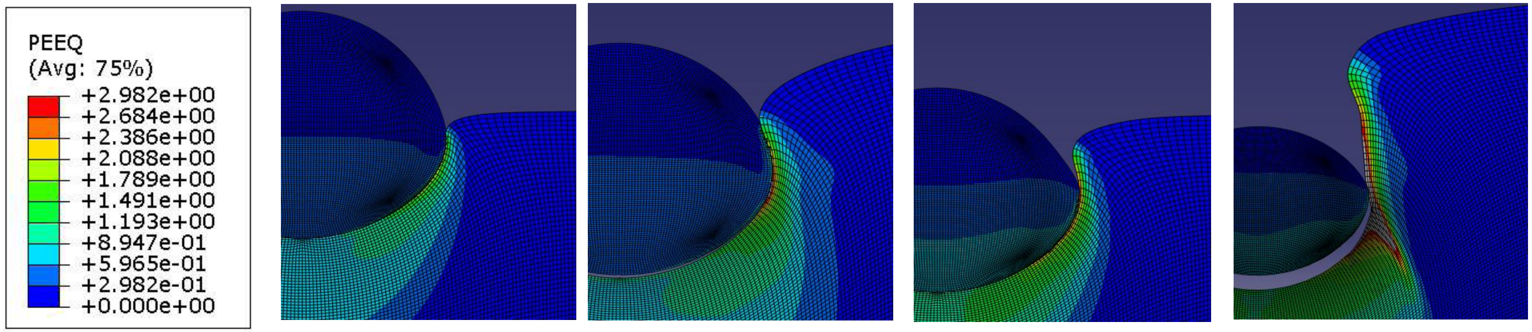


Figure 2 - Calculated profiles of (a) eq. plastic strain of the elements which found maximum strain and (b) velocity of particles, respectively.



(a) 430m/s,80ns (b) 430m/s,600ns (c) 600m/s,80ns (d) 600m/s,600ns

Figure 3 - Equivalent plastic strain distribution during the impact of *Cu* sphere against *Al* substrate with friction (f=0.3)

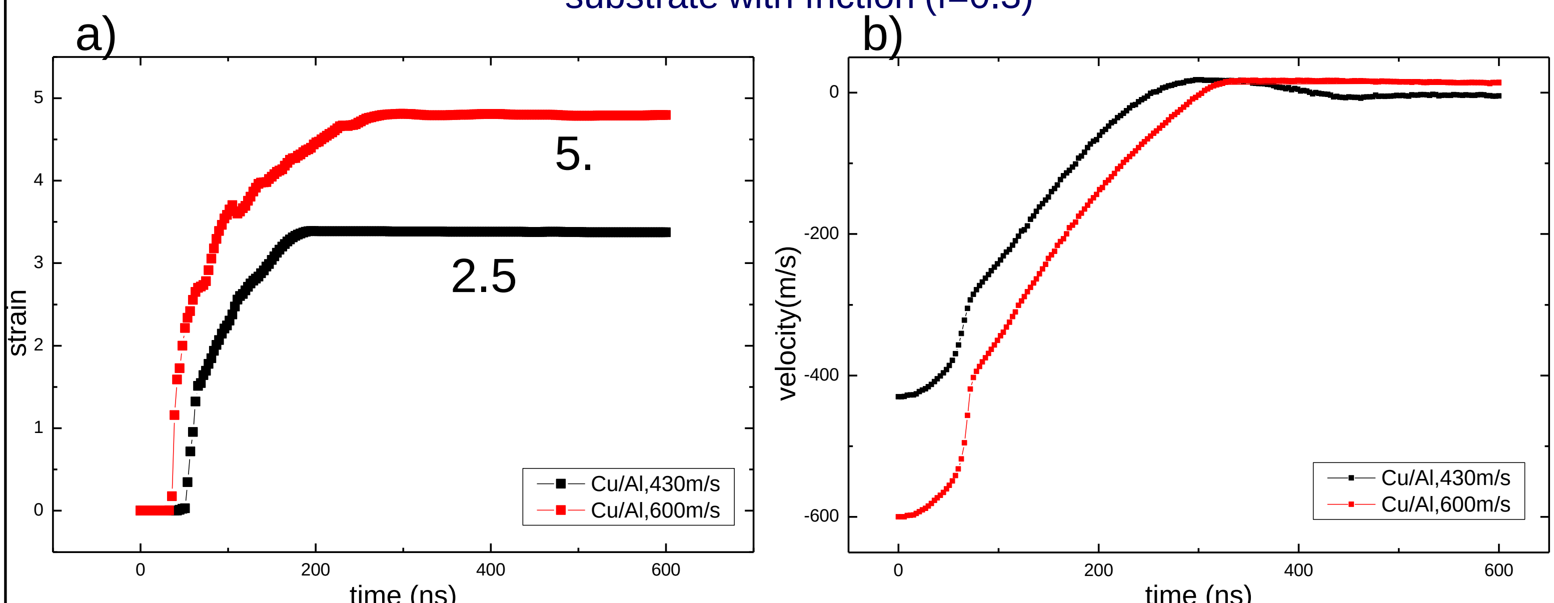


Figure 4 - Calculated profiles of (a) eq. plastic strain of the elements which found maximum strain and (b) velocity of particles, respectively.

WORK FRAME
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Cu/Al
Al/Cu
Al/Al
CONCLUSION

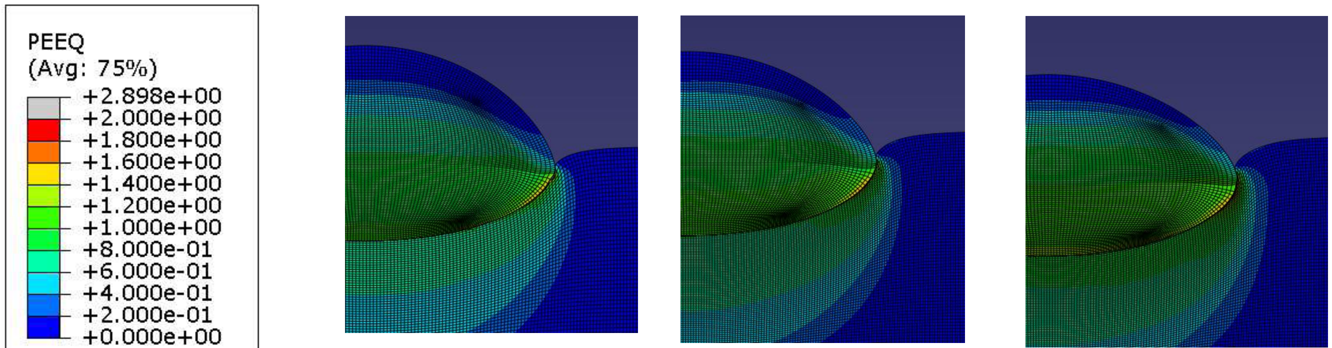

Figure 5 - Equivalent plastic strain distribution during the impact of *Al* sphere against *Cu* substrate after 80ns

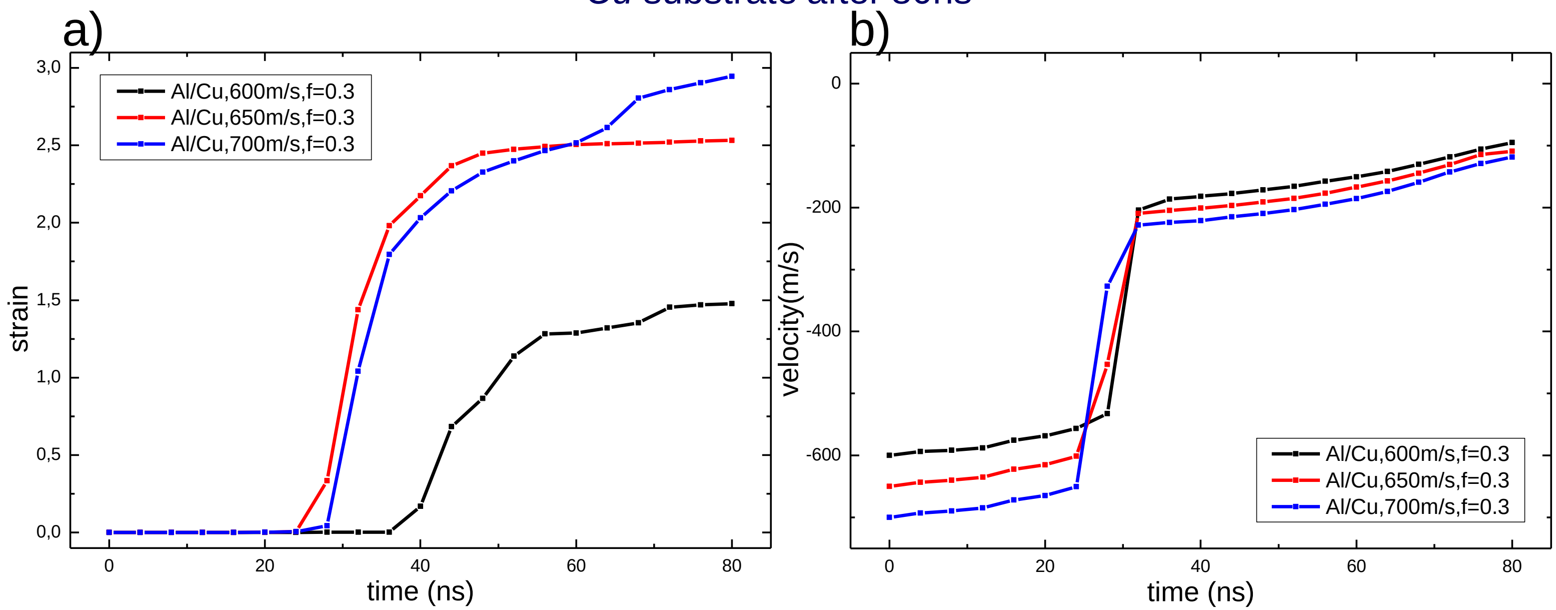

Figure 6 - Calculated profiles of (a) eq. plastic strain of the elements which found maximum strain and (b) velocity of particles, respectively.

WORK FRAME

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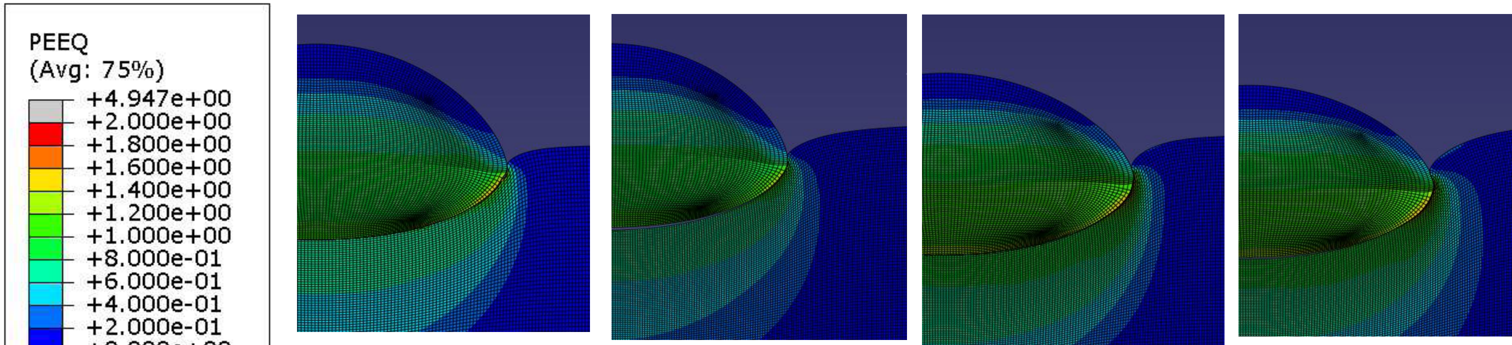
Al/Cu

Al/Al

CONCLUSION



(a) 600m/s,80ns (b) 600m/s,390ns (c) 700m/s,80ns (d) 700m/s,390ns

Figure 7 - Equivalent plastic strain distribution during the impact of *Al* sphere against *Cu* substrate with friction (f=0.3)

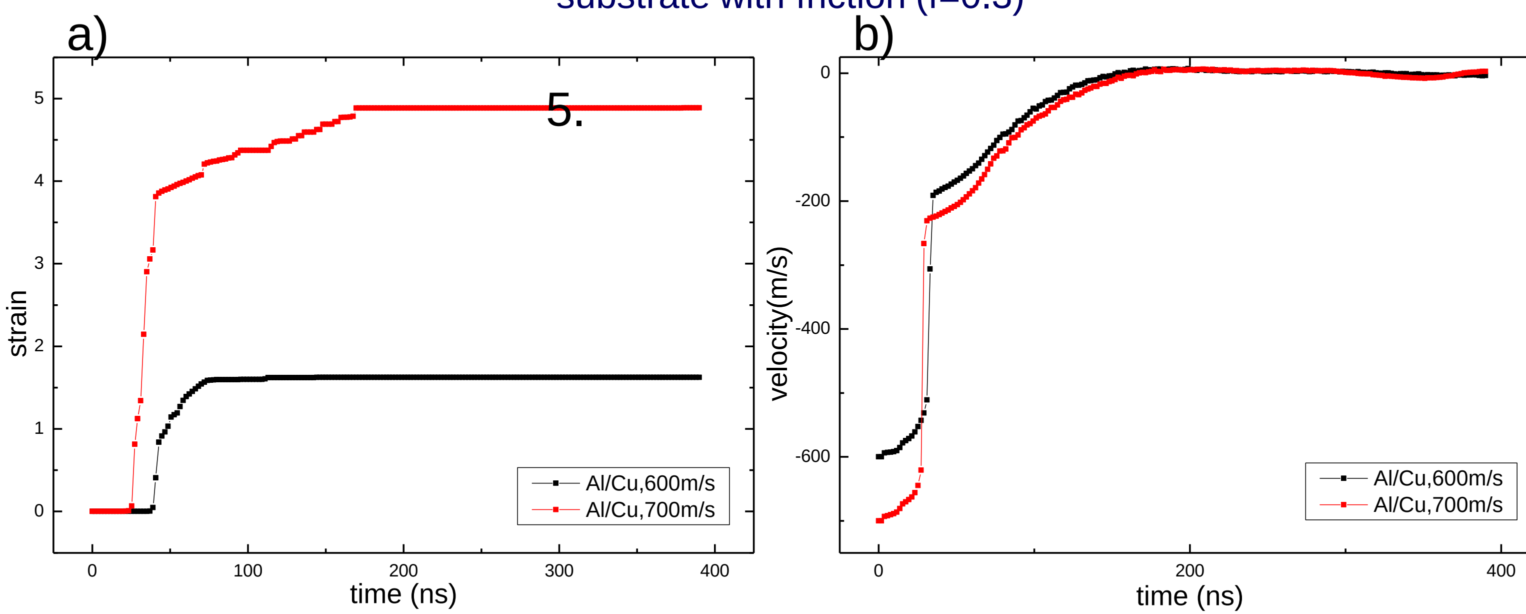
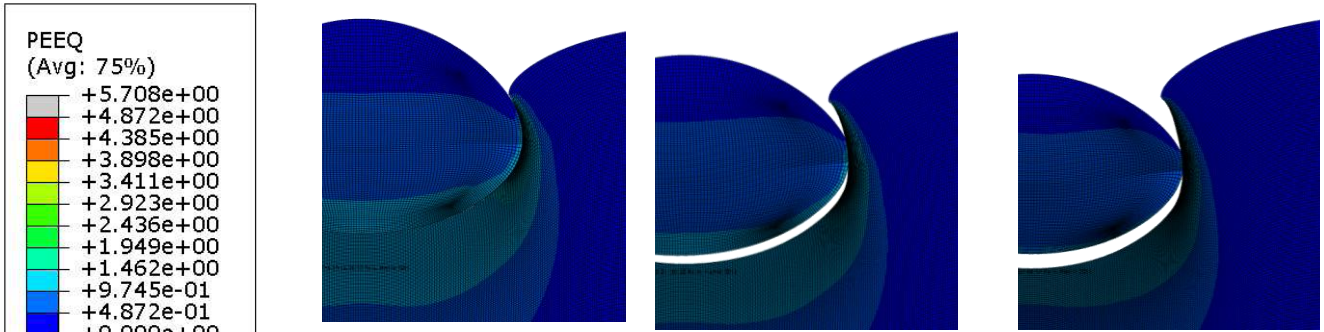


Figure 8 - Calculated profiles of (a) eq. plastic strain of the elements which found maximum strain and (b) velocity of particles, respectively.



(a) 700m/s,f=0.3 (b) 780m/s,f=0.3 (c) 840m/s,f=0.3

Figure 9 - Equivalent plastic strain distribution during the impact of *Al* sphere against *Al* substrate after 400ns

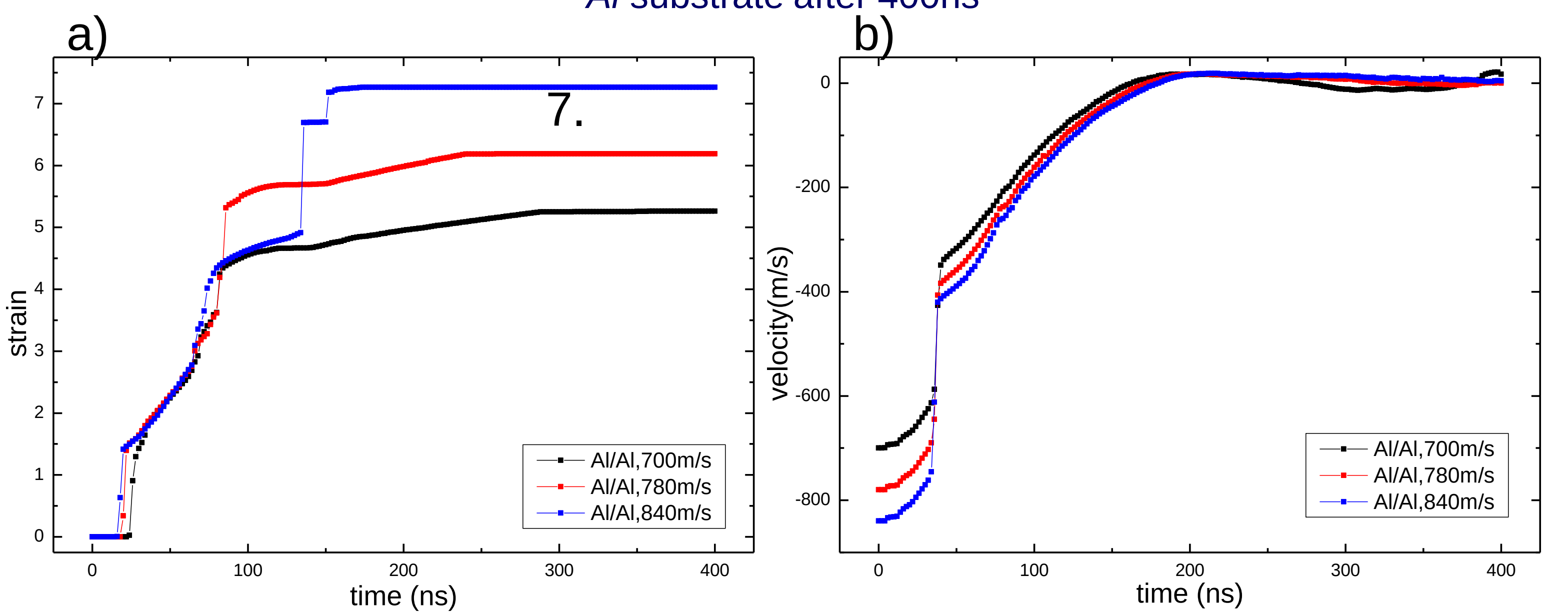


Figure 10 - Calculated profiles of (a) eq. plastic strain of the elements which found maximum strain and (b) velocity of particles, respectively.

- Very high equivalent plastic strain (>5.) near the interface in a few nm thickness. Higher is the impact velocity higher is the maximum plastic strain.
- For particle harder than the substrate, a transition from elastic-plastic deformation and viscous flow can be forecasted.
- The cavity or void is formed around the deformed particle at higher impact speeds of aluminium particle against aluminium substrate.
- Preliminary results: strain rate 1 000 000 000 s^(-1) !!
- P**erspectives:**
  - Comparison to experiments made at Tohoku Univ.
  - Benchmark with SPH model (Univ. of Tohoku, INSA…)
  - Multi-impact, creation of voids, rebound, etc…
  - Identification of material behaviour at such extremely high strain rates: on which means : Hopkinson's bar too slow…
  - Testing of samples extracted from the Cold Spray coating to compare properties with those of the base material (Al, Cu, ..?)