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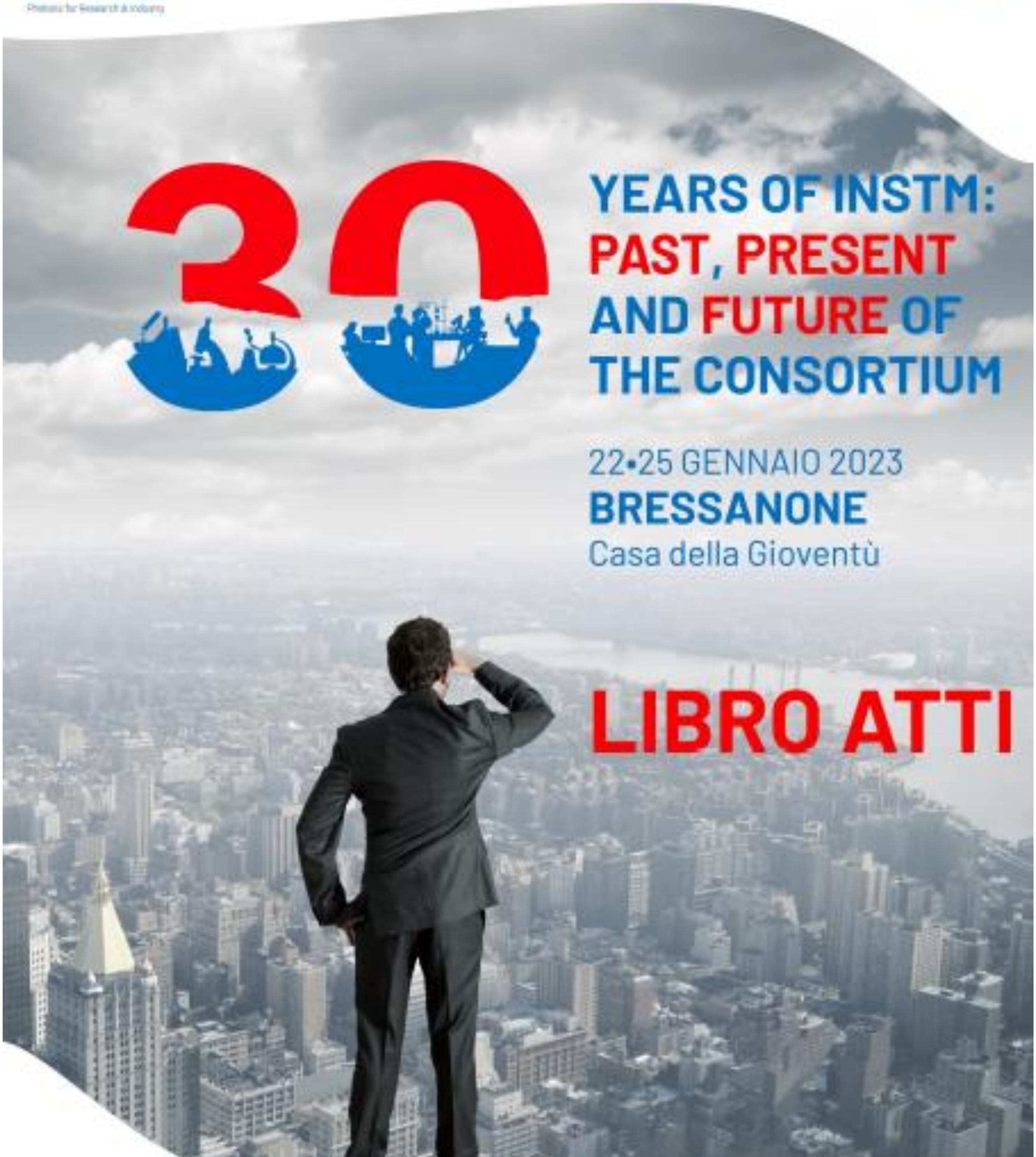

30 YEARS OF INSTM: PAST, PRESENT AND FUTURE OF THE CONSORTIUM

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OBLIQUE BALLISTIC IMPACTS ON SELF-HEALING IONOMERS

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Puncture activated self-healing is an autonomic mechanism which is exhibited by a number of thermoplastic polymers, and in particular by ionomers, provided specific conditions are met. Extensive experimental research has been conducted to study how material properties, damage circumstances, environmental conditions affect self-repair efficiency after punctures. Experimental approaches to enlighten the relationships between viscoelastic properties and temperature increase in ionomers have been employed by means of mechanical tests and thermal measurements. The self-healing properties depend on different factors such as the projectile diameter with respect to the thickness of the specimen, the impact speed, the angle of impact, the temperature and the fluid in contact with the specimen. Several impacts on panels made of thermoplastic ionomer by spherical projectiles are analyzed by experimental tests. The results of an extensive experimental campaign for the material characterization and for the impact/healing effects are reported.
The material employed in the experimental work is a thermoplastic ionomer Ethylene co-Metacrylic Acid (EMAA), whose commercial name is Surlyn® 8940 produced by DuPontTM. Flat panels 2 or 3 mm thickness were produced by compression molding. All panels were allowed to reach equilibrium conditions for at least 30 days before testing. Low velocity (160 - 200 m/s) puncture tests of polymer flat panels were conducted with steel balls launched by an air gun. In this range of velocities, different impact angles (45°-70°) were investigated. A real case application was studied by substituting one face of a cylindrical liquid tank with the ionomer under investigation. The tank was filled with water and post impact leakage was monitored.
Experimental tests showed how, at the same impact speed, an increase of the impact angle always caused the perforation of the specimen. In any case after the impact the healing event of the specimen was verified by applying a pressure difference between the two faces of the specimen in order to check for pressure variations. At low angles of impact, self healing was always observed, while at higher angles (60°-70°) self-healing occurred only at higher speeds. The presence of water did not influence the ability of the ionomer to heal.
The ionomers used for this work showed a good self-healing behaviour under different impact conditions, even if at higher impact angles, speed is a critical parameter. Also, the presence of fluid in contact does not seem to interfere with the healing mechanisms. This kind of materials could be further studied in all those applications where pressurization conservation is mandatory, as is in the space field.