Progetto di ricerca:

Il progetto di ricerca mira a sviluppare e perfezionare processi al plasma atmosferico per conferire proprietà funzionali a una vasta gamma di superfici. Attraverso l'implementazione di tecnologie innovative, si intende esplorare nuovi orizzonti nell'ingegnerizzazione delle superfici, focalizzandosi principalmente su applicazioni in ambito di modulazione delle interazioni biologiche.
Nel progetto si investigheranno e svilupperanno nuove metodologie di trattamento al plasma atmosferico, ottimizzando le condizioni operative per massimizzare l'efficienza e la versatilità del processo. Tra le proprietà superficiali di interesse e delle quali si vogliono sviluppare delle strategie di modulazione vi sono: idrofobicità/idrofilicità, biocompatibilità, stabilità in ambiente acquoso e, in caso di film sottili, adesione al substrato. Al fine di caratterizzare le superfici modificate tramite i processi plasma si prevede l'adozione di tecniche di caratterizzazione quali: misura dell'angolo di contatto, spettroscopia FTIR, microscopia a scansione, inteferometria.

Piano di attività:

Il progetto di ricerca riguarda la realizzazione e la caratterizzazione di processi plasma per la modifica di superfici, con una attenzione particolare per lo sviluppo di funzionalità che permettano di modularne le interazioni biologiche. A tal fine si prevedono le seguenti attività:

1) Sviluppo di processi di attivazione superficiale mediante plasmi atmosferici: tali processi saranno finalizzati alla creazione di gruppi funzionali sulle superfici trattate, così da incrementarne l'energia superficiale e abilitare successivi processi di grafting chimico di molecole funzionali. Si prevede di sviluppare processi per il trattamento di materiali di diversa natura (polimeri, ceramici, metalli) e morfologia (bulk, microstrutturati, fibrosi)
2) Sviluppo di processi di deposizione di film sottili mediante plasmi atmosferici: tali processi saranno finalizzati alla creazione sottili film con opportune funzionalità su substrati di diversa natura (polimeri, ceramici, metalli) e morfologia (bulk, microstrutturati, fibrosi)
3) Caratterizzazione dei sistemi plasma utilizzati per i processi di modifica superficiale: al fine di interpretare i risultati dei processi sviluppati e procedere verso una loro ottimizzazione, si prevede di analizzare i sistemi plasma mediante caratterizzazioni elettriche, con l'ausilio di oscilloscopi, sonde di tensione e corrente, e chimico-fisiche, mediante tecniche spettroscopiche in assorbimento ed emissione.
4) Caratterizzazione dei materiali modificati mediante trattamenti plasma: l'effetto dei processi plasma sulle superfici trattate sarà analizzato in termini di morfologia, mediante microscopia a scansione e inteferometria, e proprietà chimiche, mediante spettroscopia FTIR e misura dell'angolo di contatto.

Group for Industrial Applications of Plasmas laboratory equipments:
(http://plasmagroup.ing.unibo.it/)

Industrial, environmental and biomedical applications are characterized by the common need of innovative and advanced treatments aimed at enhancing specific properties of different materials (from polymers to metals, from ceramics to biological substrates). Plasma is an ionized gas, able to conduct heat and electricity, consisting of electrons, neutrals, radicals and ions. The possibility of precisely controlling plasma chemical and physical characteristics makes plasma technology the ideal candidate to solve such a varied range of needs.
The group has a strong experience in the industrial applications of plasmas, developed over more than twenty years of research in the field. A large number of research activities concern processes assisted by thermal plasmas (T=10-30kK), while an increasing volume of research activities concerns non-thermal plasmas (T

lower than 40°C) at atmospheric pressure, with particular interest for the treatment of materials and biological applications. The research approach characterizing the activities of the group integrates plasma fundamental studies with experiments, diagnostics and computer modelling for process and devices design and optimization.

Non-thermal plasma sources for material treatment and biomedical applications:

- Plasma source NEOPLAS – KINPEN for the treatment of biological and thermosensitive materials.
- Plasma source RF – Plasma Needle for the treatment of biological and thermosensitive materials.
- Plasma source RF – Plasma Tube for the treatment of biological and thermosensitive materials.
- Plasma source HV pulse – FE-DBD (Floating Electrode Dielectric Barrier Discharge) for the treatment of biological and thermosensitive materials.
- Plasma source HV pulse – DBD-Jet (Dielectric Barrier Discharge) for the treatment of biological and thermosensitive materials.
- Plasma source HV pulse – Plasma Gun for the treatment of biological and thermosensitive materials.
- Plasma source for surface modification in controlled atmosphere.
- System FB Plasma 3D for processes on materials, such as materials activation and organic and inorganic films deposition.
- High voltage pulse generator FPG 20-1 NMK, FID GmbH (rise time, 2-3 ns) for the treatment of biological and thermosensitive materials.
- High voltage pulse generator FPG 20-1PM, FID GmbH (rise time, 110-130 ps) for the treatment of biological and thermosensitive materials
- High voltage pulse generator PG100-3D – Plasma Power LLC (rise time, us) for the treatment of biological and thermosensitive materials.
- RF generator BDS300Black – BDISCOM s.r.l. (13.56 MHz, 300 W) for the treatment of biological and thermosensitive materials.
- RF generator Stolberg, 13.56 MHz, 1kW, for the treatment of biological and thermosensitive materials.
- RF generator Comet, 81,36 MHz, 1 kW, for the treatment of biological and thermosensitive materials.
- HVAmplifier (Trek model 30/20-H-CE, ± 30 kV, 20 mA) connected to a waveform generator (Stanford Research model DS335, 3 MHz), for the treatment of biological and thermosensitive materials.
- High voltage Dielectric Barrier Corona and Plasma Discharge Resonant Driver for treatment of materials
- Cost Reference Microplasma Jet

Material processing and characterization:

- System for measurement of water contact angle and surface energy (Kruss DSA4)
- System for Attenuated Total Reflectance – Fourier Transform Infrared (ATR-FTIR) spectroscopy (Agilent Cary 660 FTIR spectrometer).
- Scanning electron microscope (SEM) (Phenom ProX).
- Chemical laminar flow hood.
- Glove box for the safe handling of samples in a controlled atmosphere.
- Bubbler for monomeric suspension to produce gas carrying the monomer.
- Nebulizer system for nanocolloids to produce aerosol carrying nanoparticles.
- System for the measurement of specific surface area in solid samples by means of BET technique (NOVA 2200e, Quantachrome Instrument), for the characterization of nanopowders.

Raizer Advanced Plasma Diagnostics Laboratory:

- Acquisition system for electrical data (Oscilloscope, high voltage and current probes).
- High-speed camera NAC-MEMRECAM K3 for visualization and diagnostics of plasma assisted processes.
- Diagnostics system for Schlieren photography of plasma assisted processes.
- System for plasma diagnostics by means of Optical Emission Spectroscopy.

- High-speed camera NAC-MEMRECAM GX3 for visualization and diagnostics of plasma assisted processes.
- Enthalpy probe for temperature, velocity and composition measurement in thermal plasmas.
- Intensified CCD camera (ICCD) PI-MAX3:1024i, Princeton Instruments with nanosecond exposure time, for time-resolved Optical Emission Spectroscopy and visualization of transient in plasma processes.
- Fiber optic sensor for temperature measurement AccuSens in non-thermal plasmas.
- High precision infrared portable thermometer OPTRIS.
- Camera and lens NIKON for scientific publications.
- Superzoom lens for Edmund optics K2 iCCD.
- Fluoroskan Ascent 100-240V, 50/60 Hz
- Optical Absorbtion Spectroscopy system

Langmuir-Tesla BioPlasma laboratory:
Biological laboratory equipped for cultivation and manipulation of pathogens up to class 2, licensed by the Office for protection and prevention (Document of Risk Assessment sent to AUSL on march 15, 2013) which include:
- Laminar flow hood Class 2.
- Fridge-freezer for storage of bacteria and pathogens.
- Incubator for bacterial growth on plates.
- Heated and vibrant support for the growth of bacteria in culture medium.
- Autoclave for sterilization of non-disposables.
- Demineralizer.
- Movable hood for manipulation of chemical compounds.
- Waste storage system authorized by School of Engineering and Architecture – waste management office.

Golgi BioPlasma-Cell laboratory
Biological laboratory fully equipped for storage, growth and analysis of eukaryotic cell lines. The laboratory includes:
- Laminar flow hood Class 2.
- Fridge, freezer and liquid nitrogen canister for storage of cell lines.
- CO2 incubator for cell growth.
- Refrigerated laboratory centrifuge.
- Autoclave for liquid and solid sterilization.
- Thermomixer for controlled heating of cells and culture broths.
- Microplate reader for cell analysis, e.g. MTT and ELISA assay.
- Spectrophotometer for chemical analysis.
- Inverted microscopy for morphological analysis.