SUB. F

DA CONSEGNARE AL <u>COORDINATORE DEL CORSO</u> PER LA PRESENTAZIONE DEL DOTTORANDO AL GIUDIZIO DEL COLLEGIO DEI DOCENTI IN VISTA DELL'ESAME FINALE

SCHEDA INFORMATIVA SULLE ATTIVITA' DEL TRIENNIO

- **Cognome e Nome**: *Raffaele Ciardiello*
- **Titolo di studio posseduto**: *Laurea magistrale in Ingegneria Meccanica*

conseguito in data *09/07/2014* **presso l'Università/Politecnico di** *Seconda Università degli studi di Napoli*

- **Dottorato di Ricerca in** *Ingegneria Meccanica*
- **Ciclo***XXX* **Anni accademici di riferimento** *2014-2017*
- **Dipartimento**: *Dipartimento di Ingegneria Meccanica e Aerospaziale*
- **Coordinatore** *Professor Luigi Garibaldi*
- **Tutore** *Professor Giovanni Belingardi*
- **Titolo della Tesi di Ricerca** (in Italiano e/o in Inglese) *Functionalization of adhesives and composite matrix by micro and nanoparticle addition.*

A. DESCRIZIONE DELL'ARGOMENTO DELLA TESI (massimo 20 righe)

The topic of my work is focused on the recent use of micro and nano particles as a mean to functionalize material. Recently, the use of particles has been widely studied in order to functionalize materials. In our case, we investigated the possibility to add hollow glass microspheres and conductive particles in order to obtain a lightweight conductive material. Conductive particles, such as, graphene and carbon black, were added in order to obtain a conductive material. Test performed on the materials evidenced that the lighter materials exhibits good mechanical properties, in particular when carbon black were used. However, the carbon concentration was not enough to make the material conductive. The second part of my work is focused on the separation of thermoplastic adhesive with the use of metallic nanoparticles (iron and iron oxide) coupled with electro-magnetic processes or microwave. A mechanical and thermal characterization of the modified adhesive was performed and the feasibility of this technique has been evaluated for its applicability. This adhesive were evaluated also under impact. The studies evidenced that the separation of adherents is possible using different particles weight concentrations 3%, 5% and 10% of iron oxide. The study focused also on the optimisation and influence of the induction heating parameters. Furthermore, the separation of adhesive was studied coupling microwave coupled with particles in the hot-melt adhesive. Also in this case, the mechanical and thermal proprieties of the adhesive were studied. The study showed that this system has the potentiality to separate adhesive.

B. ATTIVITA' DI RICERCA SVOLTA NEL TRIENNIO

B.1 descrizione complessiva e sintetica dell'attività di ricerca

The topics of my PhD activity are two:

The main topic of my activity is separation of thermoplastic adhesive by mean of electro-magnetic induction and microwave of thermoplastic adhesives modified by nanoparticles. The activity covers the mechanical and thermal characterisation of the adhesives, modified and not. Furthermore, the induction and microwave processes have been optimised and analysed. The aim of this work was to understand the best parameters configuration for the separation in terms of separation time.

Another part covers the study of the use of hollow glass spheres to reduce the weight of epoxy matrix. The mechanical e thermal properties of these material were studied together with the possibility to use conductive nanoparticle that can make the material conductive.

B.2 argomenti di ricerca specifici affrontati

1. *Adhesive bonding.*
2. *Impact tests.*
3. *Chemical and thermal characterization of the materials.*
4. *Syntactic foams.*
5. *Conductive materials.*
6. *Induction heating and microwave.*

B.3 risultati più rilevanti ottenuti nel triennio

1. *Possibility to de-bond easily thermoplastic adhesives modified with relatively low concentration of iron oxide nanoparticles.*
2. *Possibility to de-bond thermoplastic adhesive modified with graphene nanoplatelets coupled microwave.*
3. *Possibility to lightweight composite matrix by mean of hollow glass microspheres.*

B.4 collaborazioni di ricerca avute con Università, Centri di ricerca ed Industrie nazionali ed internazionali (specificare il quadro entro cui sono avvenute: contratti di ricerca, periodi di formazione, ecc.)

1. *During these three years, we collaborated with the researcher of the Centro Ricerche Fiat (CRF) of Torino and Pomigliano D'arco (NA). More in details, we collaborated with the Group Material Lab (GML). This collaboration started with a period of training the laboratories of Pomigliano. The duration of the training period was one year throughout I learned the basics on the nano-modified adhesive and electro-magnetic process. During the training period, I used their laboratories for the preparation of the material needed for my research.*
2. *Collaboration with the Department of Chemistry and NIS Research Centre, University of Torino, Torino. This collaboration was very important in order to deepen the chemistry of the micro and nano-particles and the compatibility between adhesive and particles.*
3. *Collaboration with KGR S.p.A, Brandizzo (TO). We collaborated with this company to optimise the parameters of the inductor that influence the electo-magnetic induction processes.*
4. *Collaboration with Termomacchine, Rivalta di Torino (TO). We collaborated with this company to optimise the parameters of the inductor that influence the electo-magnetic induction processes.*
5. *Collaboration with Michigan State University, East Lansing (US). In this case, I spent 6 months in their laboratory in order to learn the more recent techniques concerning the*

dispersion of nano and micro particles in a composite matrix. We worked together on the possibility to make a material conductive.

6. *Collaboration with Cambridge Graphene Centre, University of Cambridge, U.K. With this centre we collaborated on the possibility to use microwave coupled with graphene modified adhesive in order to de-bond adhesives.*

B.5 ulteriori attività di ricerca (progetti e contratti di ricerca nazionali ed internazionali)

B. 6 brevetti conseguenti l'attività di ricerca

B. 7 altre attività che si ritengono degne di menzione

C. ATTIVITA' DI FORMAZIONE

C.1 partecipazione ad attività interne di supporto alla didattica (specificare su quali corsi, e se eventualmente il dottorando sia stato nominato cultore della materia)

C.2 corsi e seminari più significativi seguiti (interni, esterni, ecc. - indicare solo il tipo ed il numero)

C.3 periodi di formazione esterni al Politecnico (tipo di formazione, luogo e durata)

1. Centro Ricerche Fiat (CRF), Pomigliano D'arco (NA). 16/6/2015-16/6/2016.
2. Michigan State University, East Lansing (USA). 24/06/2016-22/12/2016.

D. PUBBLICAZIONI FATTE E IN CORSO (indicarne il numero e il tipo: riviste nazionali ed internazionali, congressi, capitoli libri ecc.)

1. The International Conference on Enhanced Safety of Vehicles.

CRITICAL REVIEW OF THE CURRENT ASSESSMENT APPROACHES FOR FRONTAL CRASH COMPATIBILITY REGARDING THE EVALUATION OF STRUCTURAL INTERACTION, E. Sadeghipour, F. Duddeck, M. Fischer, M. Lienkamp, R. Ciardiello

2. The International Conference on Composite Materials.

GRAPHENE-BASED COMPOSITE MATERIALS FOR AUTOMOTIVES, A. Elmarakbi, W. Azoti, B. Martorana, G. Belingardi and R. Ciardiello

3. The European Conference on Composite Materials.

A STUDY OF PHYSICAL AND MECHANICAL PROPERTIES OF A NANOMODIFIED THERMOPLASTIC ADHESIVE IN NORMAL AND ACCELERATED AGEING CONDITIONS
R. Ciardiello, G. Belingardi, B. Martorana, D. Fondacaro and V. Brunella

4. EURAD 2016, ADHESION 16.

INFLUENCE OF THE INDUCTION HEATING PROCESS ON A NANO-MODIFIED ADHESIVE FOR AUTOMOTIVE APPLICATIONS.
R. Ciardiello, G. Belingardi, B. Martorana and V. Brunella

5. International Conference on Automotive Composites-ICAutoC 2016.

MECHANICAL PROPERITES OF A THERMOPLASTIC ADHESIVE MODIFIED WITH GRAPHENE NANOPLATELETS FOR AUTOMOTIVE APPLICATIONS.
R. Ciardiello, G. Belingardi, B. Martorana, F. Bertocchi, F. Cristiano, M. Zanetti and V. Brunella.

6. Book Chapter for the book “Adhesive” edited by A. Rudawska. InTech – Open access publisher.

THERMOPLASTIC ADHESIVE FOR AUTOMOTIVE APPLICATIONS.
G. Belingardi, B. Martorana, V. Brunella and R. Ciardiello.

7. Article: Journal of adhesion 2017.

IMPACT RESPONSE OF ADHESIVE REVERSIBLE JOINTS MADE OF THERMOPLASTIC NANOMODIFIED ADHESIVE., R. Ciardiello, A. Tridello, V. Brunella, B. Martorana, D.S. Paolino and G. Belingardi.

8. Article: Composite Structures 2017.

EFFECTS OF CARBON BLACK AND GRAPHENE NANO-PLATELET FILLERS ON THE MECHANICAL PROPERTIES OF SYNTACTIC FOAM. R. Ciardiello, L.T. Drzal and G. Belingardi.

9. Article: Journal of Mechanical Engineering Science 2017.

IRON-BASED REVERSIBLE ADHESIVES: EFFECT OF PARTICLES SIZE ON MECHANICAL PROPERTIES. R. Ciardiello, B. Martorana, V.G. Lambertini and V. Brunella (accepted on 20-7-17).

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(firma del Tutor)

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