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DEVELOPMENT, CHARACTERIZATION, AND APPLICATIONS OF GOLD AND PLATINUM BULK METALLIC GLASSES

Thesis by

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In Partial Fulfillment of the Requirements

for the Degree of

Doctor of Philosophy

California Institute of Technology

Pasadena, California

2007

(Defended May 2nd, 2007)

To My Parents

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ACKNOWLEDGMENTS

I would like to express my deepest appreciation to Prof. Johnson for his continuous support, advice, and encouragement. His genuine enthusiasm and optimism in science has created the best research atmosphere I could ever dream of. Our Keck Lab's roof-top discussions have always been my endless supply of energy, optimism, inspiration and ideas. My special thanks go to Prof. Jan Schroers, Dr. Donghua Xu, and Jin-yoo Suh for the research collaboration, discussions, encouragement, and life-long friendship. I am grateful to my thesis committee—Prof. Haile, Prof. Fultz, Prof. Ravichandran, and Prof. Johnson—for spending the time on my past candidacy, this thesis, and the thesis defense.

I would like to acknowledge many wonderful people who make my Caltech experience an extraordinary one—Prof. Marc Nicolet, Prof. Konrad Samwer, Prof. Ursan Ustundag, Prof. Dale Conners, Mike Vondrus, Carol Garland, Channing Ahn, Pamela Albertson, Robin Hanan, Sven Bossuyt, Haein Choi-Yim, Andy Waniuk, Paul Kim, Marios Demetriou, Hyon Jee Lee, Sun-Yub Lee, Can Aydiner, Alex Papandrew, Robert Rogan, Olivier Delaire, Gang Duan, Greg Welsh, Chris Veazey, Mary Laura Lind, Joe Schramm, Rebecca Stevens, John Harmon, Aaron Weise, Jim Endrizzi, Athena Trentin, Tracy Kidd, and, of course, Ernie. I also thank Stefan Tatarowski who is my landlord, my American culture counselor, my proofreader, and my friend.

Last, but certainly not least, I thank my parents, my grandmother, and my sister for sending me their unconditional love and support from half-way around the globe for twelve straight years that I have been away from home. I thank Peer, my wife and my

life-long friend, who has always been supportive and patient. I could not have done this without you.

This thesis work is financially supported by the Royal Thai Government, Defense Advanced Research Projects Agency (DARPA), Liquidmetal Technologies, and the Intel Corporation.

ABSTRACT

The development of bulk metallic glass alloys is presented with various elemental selection criteria, design strategies, and experimental techniques. The focus was later drawn towards the development of noble bulk metallic glasses based on gold and platinum. To formulate a good bulk glass forming composition, we found that the gold alloys had to be optimized using uncommon approaches. One strategy was to primarily increase the glass transition temperature of the alloy, instead of lowering the melting temperature. The resulting gold bulk metallic glass alloy could be cast fully amorphous up to 5 mm thick. However, the best gold glass former also exhibited many anomalous behaviors; for example, a very high strain rate could induce phase separation in the bulk glass forming liquid. A detail study on the strain rate induced crystallization was carried out systematically to pinpoint the exact conditions that would cause an anomaly.

Additionally, a variety of comparative studies were conducted on the gold and platinum bulk metallic glass alloys, including elastic constants measurement, heat capacity measurement, viscosity measurement using three-point beam bending, and time to crystallization study in order to construct a Time-Temperature Transformation diagram.

The last chapter switches gears to the engineering and technology aspect of gold and platinum bulk metallic glasses. The thermoplastic soldering technique is introduced as a novel method for joining any two materials at temperatures lower than that of brazing or welding processes. The proposed technique is a new alternative to the lead-free soldering process available to the electronic industry.

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