

# NIST Measurement Needs Workshop on Additive Manufacturing of Ceramics November 13-14, 2019

| FINAL am           | Wednesday<br>13-Nov-19  | Thursday<br>14-Nov-19  | Times  |
|--------------------|---|--|--------|
| 8:00 - 8:35 am     | Registration, breakfast   | Breakfast  | 35 min |
| 8:35 am - 8:45 am  | <b>Welcome &amp; Workshop Charge</b><br>Andrew Allen & Igor Levin (NIST)  | <b>Workshop Charge &amp; Reprise of 1st Day</b><br>Andrew Allen & Igor Levin (NIST)  | 10 min |
| 8:45 - 9:00 am     | <b>Opening remarks: Mike Fasolka</b> , MML Lab<br>Deputy Director   | <b>Opening remarks: David Holbrook</b> , MMSD<br>Division Chief  | 15 min |
|                    | <b>Session A; Chair: Dileep Singh</b> , Argonne<br>National Lab.  | <b>Session D; Chair: Tao Sun</b> , University of<br>Virginia   |        |
| 9:00 - 9:15 am     | <b>Kalman Migler</b> , NIST MS&D: <i>NIST<br/>Polymers AM Program</i>   | <b>Mark VanLandingham</b> , MS&D Division Chief:<br><i>NIST Metals &amp; Alloys AM Program</i>                                       | 15 min |
| 9:15 - 9:45 am     | <b>Cathleen Hoerl</b> , GE Global Research: <i>The<br/>current state of ceramic AM and the GE<br/>Research approach</i>             | <b>Tobias Schaedler</b> , HRL Labs: <i>Additive<br/>manufacturing of reinforced polymer-derived<br/>ceramics</i>                     | 30 min |
| 9:45 - 10:10 am    | <b>Beth Armstrong</b> , ORNL: <i>Ceramic<br/>AM in energy, a case study in characterization<br/>and application</i>                 | <b>Matt Dickerson</b> , AFOSR: <i>Development<br/>and additive manufacturing of preceramic<br/>polymer-based systems</i>             | 25 min |
| 10:10 - 10:30 am   | <b>Coffee break</b>   | <b>Coffee break</b>  | 20 min |
|                    | <b>Session B; Chair: Todd Heil</b> , Theradaptive,<br>Inc.  | <b>Session E; Chair: Walter Zimbeck</b> , Johns<br>Hopkins University  |        |
| 10:30 - 10:55 am   | <b>Shawn Allan</b> , Lithoz Inc.: <i>Opportunities &amp;<br/>challenges in ceramic additive manufacturing<br/>for healthcare</i>    | <b>Peter Durcan</b> , 3DCeram-Sinto: <i>A viable future<br/>for additive ceramics</i>  | 25 min |
| 10:55 - 11:20 am   | <b>Thomas Henriksen</b> , Ceramco:<br><i>Conventionalization of ceramic additive by an<br/>OEM ceramics manufacturer</i>            | <b>Sara Randall</b> , Lucideon Company: <i>Adopting<br/>disruptive technologies - the case of ceramic<br/>additive manufacturing</i> | 25 min |
| 11:20 - 11:45 am   | <b>Greg Hayes</b> , EOS: <i>Solution engineering: how<br/>ceramic composites can drive production in<br/>additive manufacturing</i> | <b>Rick Lucas</b> , ExOne:<br><i>Binder jetting friend or foe to ceramic injection<br/>molding</i>                                   | 25 min |
| 11:45 - 12:10 pm   | <b>Dan Sokol</b> , REN Services Inc.: <i>Ceramic<br/>additive manufacturing enables rapid precision<br/>castings</i>                | <b>Greg Pugh</b> , Tethon3D: <i>Selected case studies in<br/>ceramic additive manufacturing</i>                                      | 25 min |
| 12:10 pm - 1:15 pm | <b>Boxed Lunch, Working Discussions</b>   | <b>Boxed Lunch, Working Discussions</b>  | 65 min |

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| FINAL pm       | <b>Session C; Chair: Michael Baldwin,</b><br>Honeywell Aerospace   | <b>Session F; Chair: James Weigner,</b> Lockheed<br>Martin RMS  | <b>Times</b> |
|----------------|--|---|--------------|
| 1:15 - 1:40 pm | <b>Lionel Vargaz-Gonzales</b> , ARL: <i>Additive manufacturing as an enabler for complex, hierarchical ceramic armors</i>  | <b>Chris Spadaccini</b> , LLNL: <i>Additive manufacturing and architected materials: new process developments and materials</i>   | 25 min       |
| 1:40 - 2:05 pm | <b>Mike Halbig</b> , NASA Glenn: <i>Additive manufacturing of ceramics for aerospace applications</i>  | <b>Tom Wasley</b> , MTC, UK: <i>Ceramic additive manufacturing: the UK road to technology adoption</i>  | 25 min       |
| 2:05 - 2:30 pm | <b>Rodney Trice</b> , Purdue U.: <i>Quantifying the properties required for direct write printing of ceramic suspensions</i>   | <b>Adam Jakus</b> , DimensionInx: <i>Additive manufacturing of emerging tissue reparative and regenerative ceramics and ceramic-based biomaterials: requirements and increasing needs for new standards</i> | 25 min       |
| 2:30 - 2:55 pm | <b>David Bourell</b> , U. Texas Austin: <i>Indirect additive manufacturing of ceramics</i>   | <b>Mark Mirotznik</b> , U. Delaware: <i>Additive manufacturing of ceramics for high temperature electromagnetic applications</i>  | 25 min       |
| 2:55 - 3:20 pm | <b>Ryan Wicker</b> , UTEP: <i>Additive manufacturing of functional ceramics: ongoing research progress and directions within UTEP's W.M. Keck Center for 3D Innovation</i> | <b>Ian Reaney</b> , U. Sheffield: <i>The role of ultra low sintering temperature ceramics in the fabrication of RF components through 3D printing</i>   | 25 min       |
| 3:20 - 3:40 pm | <b>Coffee break</b>  | <b>Coffee break</b>   | 20 min       |
| 3:40 - 4:00 pm | <b>Discussion Session (3:40 - 4:40 pm)</b><br>Leaders: <b>Igor Levin</b> (NIST) & <b>Cathleen Hoerl</b> (GE Global Research)   | <b>Discussion Session (3:40 - 4:40 pm)</b><br>Leaders: <b>Andrew Allen</b> (NIST) & <b>Anand Kulkarni</b> (Siemens, NC)   | 60 min       |
| 4:00 - 4:20 pm |  |   |              |
| 4:20 - 4:40 pm |  |   |              |
| 5:00 PM        | <b>Depart for Group Dinner</b>   | <b>Concluding Remarks</b>   | 20 min       |