MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Poster Session (P)

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INK-JETTED FUNCTIONAL CIRCUITRY FOR HEATERS AND STRAIN-GAUGES AEROSPACE APPLICATIONS

Abstract

Inkjet printing technology has recently gained attention for its numerous advantages: fabrication simplicity, compatibility with different substrates, feasibility of non-contact and no-mask patterning, low temperature processing, and low cost. Major innovation stands in the potential to expand beyond printing, to manufacturing and deposition applications, due to the ability to deposit small droplets in a precise and repeatable format. Moreover, printed electronics allows to realize electrical paths free of discontinuity and to give traditional aerospace structures new functionalities, by simply printing the circuitry directly on the component, with no intermediate manufacturing steps. In such frame, this paper is aimed to provide a meaningful insight into a joint project between Airbus Defence Space and IIT, in the frame of RD. Two different application have been studied: strain-gauge device onto SiC substrates and heater device onto aluminum substrates. A major advantage of inkjet functional circuitry for aerospace applications is reduction of floating harness, limiting the influence of mechanical shocks and vibration, thereby reducing mass as well. Another important aspect is the elimination of bonding between device and substructure and related problems (e.g. thermal expansion, off-gassing, de-bonding). Furthermore, the possibility to print heaters directly on the surface allows controlling the thermal environment of almost any structural part. Similarly, direct printing of strain gauges on the SiC parts would allow the device implementation on the structure, surviving all the mechanical and thermal environments without any degradation. The ink formulation process regarded many aspects (e.g. interaction and compatibility between ink and substrate, deposition specs, thermal treatment, operational environment, expected lifetime, performance and disposability) and a high resistivity ink based on silver nanoparticles was selected and tested for both applications. As regards the SiC substrate, preliminary printing tests showed a successful behaviour. In fact, no additional insulating layer was needed to ensure good electrical response and good adhesion between the substrate and the printed tracks. On the other hand, aluminum substrate required insulation and a first attempt was to anodize the surface. Nevertheless, tests showed the insulating strategy was inadequate. For this reason, it is currently under development a back-up strategy involving an insulating ink. Further developments and possible enhancements may also regard new ink compositions, which may lead to an increased electrical performance. Moreover, alternative substrates will be considered in order to expand the possible applications. Finally, the next future is expected to be particularly interesting for functional inkjetted circuitry, because of 3D printing advent.