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Development of Silicide Contacts for CMOS devices: Advantages of using Synchrotron Radiation

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Silicide films have been used for close to two decades as the contact to the source, drain and gate of state-of-the-art complementary-metal-oxide-semiconductor (CMOS) devices. The desired properties for this contact layer have limited the choice of applicable silicides to low resistivity $TiSi_2$, $CoSi_2$ and NiSi. The stringent and evolving requirements in material properties imposed by continuous scaling have forced modifications to current materials or implementation of the following best candidate. The recent conversion from $CoSi_2$ for the 90 nm technology to NiSi in 65 nm technology and beyond represent a good example of the complexity associated with the integration of a new material. The requirements necessary to achieve performance in current devices are so stringent that even a material such as NiSi studied for more than 3 decades exhibited unexpected characteristics in very thin films and in small devices. The use of intense x-ray beams allows for the characterization of such materials in reduced dimensions and has brought to light multiple unknown behaviors. For example, the morphological stability of NiSi is much lower than originally expected, a result of the complexity in the phase sequence, of the strong anisotropy in properties related to the non-cubic crystal structure and of the very peculiar texture of these films. This early thermal degradation of the contacts has been controlled through process optimization and recently through the use of Ni alloys. In this presentation the impact of using intense x-ray sources for materials optimization will be discussed. The access to these powerful setups has allowed the rapid characterization and optimization of large parameter spaces necessary to develop the knowledge for implementation of new materials in state-of-the-art devices.