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Magnesium based nano-composites: Light weight, environment friendly, mechanically superior materials of future

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Magnesium is the lightest structural metal in the periodic table and sixth most abundant material in the earth's crust that can be used in weight critical applications at an affordable cost. Magnesium based materials can provide further 30-35% weight saving over aluminum based materials in multiple weight critical engineering applications. Besides, magnesium possesses several other benefits like excellent castability, high damping capacity, good electromagnetic shielding, excellent machinability and less energy requirement in production compared to aluminum. From environmental perspective, fuel savings and reduced emission of greenhouse gases is the natural outcome expected if magnesium based materials are actively used. Moreover, magnesium is one of the metals that is naturally found in human body and so it can be categorized under green metals category unlike aluminum which can lead to Alzheimer disease, if consumed. In view of the multiple advantages of magnesium, efforts are made to synthesize magnesium based nano-composites and metastable composites using energy efficient solidification and microwave assisted processes. Results obtained so far indicate that nano-size reinforcements have significant potential in enhancing tensile, compressive, dynamic, fatigue, high temperature strength retention and machining properties. In addition, oxidation and wet corrosion properties can also be enhanced using nano-size reinforcements which are also very critical for structural applications. In view of the positive results obtained so far, efforts are made to upscale the solidification processing technique to pilot plant level and to integrate new magnesium based materials in selected engineering applications.

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Optical three-axis tactile sensor and its applications

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To enhance robotic performance, robots should obtain information about the environment and objects in it via multi-modal sensations such as vision, hearing and tactile sensing. Since tactile sensation is required to achieve dexterous manipulation, several tactile sensor designs have been proposed in robotics. Our three-axis tactile sensor is produced with a unique design that can measure not only normal force but also tangential force distribution caused by contact between a robotic finger and an object. The three-axis sensor is composed of small cylindrical sensing elements of rubber, an aluminum dome, an acrylic dome, a light source, a fiberscope and a CCD camera. The aluminum dome has 41 holes arranged concentrically, into which the sensing elements are inserted; the acrylic dome illuminated by a light source is inserted into the aluminum dome beneath the sensing elements. When an object touches the array of sensing-element tips, the sensing-element bottoms touch the acrylic dome. Since diffusion reflection occurs at the contact points, which are observed by the CCD camera, tactile information between the object and sensing-element tips is obtained as image data. The normal and tangential forces are obtained from integrated gray-scale values and centroid movement of brightness distribution. We produced a dual hand-arm robot equipped with three-axis tactile sensors on it fingertips. To evaluate the three-axis tactile sensor, we are conducting experiments using the robot to perform such tasks as cap twisting, block assembly and passing an object from the robotic hand to a person's hand.

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